

Climato-economic habitats support patterns of human needs, stresses, and freedoms

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Abstract: This paper examines why fundamental freedoms are so unevenly distributed across the earth. Climato-economic theorizing proposes that humans adapt needs, stresses, and choices of goals, means, and outcomes to the livability of their habitat. The evolutionary process at work is one of collectively meeting climatic demands of cold winters or hot summers by using monetary resources. Freedom is expected to be lowest in poor populations threatened by demanding thermal climates, intermediate in populations comforted by undemanding temperate climates irrespective of income per head, and highest in rich populations challenged by demanding thermal climates. This core hypothesis is supported with new survey data across 85 countries and 15 Chinese provinces and with a reinterpretative review of results of prior studies comprising 174 countries and the 50 states in the United States. Empirical support covers freedom from want, freedom from fear, freedom of expression and participation, freedom from discrimination, and freedom to develop and realize one's human potential. Applying the theory to projections of temperature and income for 104 countries by 2112 forecasts that (a) poor populations in Asia, perhaps except Afghans and Pakistanis, will move up the international ladder of freedom, (b) poor populations in Africa will lose, rather than gain, relative levels of freedom unless climate protection and poverty reduction prevent this from happening, and (c) several rich populations will be challenged to defend current levels of freedom against worsening climato-economic livability.

Keywords: challenges; climatic demands; climato-economic; collectivism; cultural anthropology; existence needs; fundamental freedoms; global warming; niche construction; threats

1. Introduction

All living species evolve links between their natural habitats and their natural habits. This paper focuses on human populations, their stresses in cold and hot seasons, and their use of money as an adaptational tool. The main idea is that needs-based stresses, goals, means, and outcomes are shaped differently in poor areas with demanding winters or summers (*threatening habitats*), in poor and rich areas with undemanding climates (*comforting habitats*), and in rich areas with demanding winters or summers (*challenging habitats*). Reinterpreting, organizing, and extending prior evidence, I attempt to relate collective stresses, goals, means, and outcomes in these three types of habitats to collective freedoms, which vary dramatically around the globe down to the point of unconcealed repression.

Freedoms are defined here as opportunities to be able to make and implement autonomous choices of goals, means, and outcomes. In addressing collective freedoms of choice, the Universal Declaration of Human Rights and the United Nations Development Programme (2000) share basically the same objectives. Both reflect a common motivation to advocate and secure freedom in all societies on earth, notably including freedom from want; freedom from fear; freedom of expression and participation; freedom from discrimination;

and freedom to develop and realize one's human potential. More or less all of these freedoms are also insightfully addressed in the work of major philosophers and lawyers considering human rights (e.g., Donnelly 2006; Dworkin 1978; Kanger 1985), and in the work of economists and political scientists concentrating on human development (e.g., Inglehart & Welzel 2005; Sen 1999). Indeed, there is broad consensus about what important freedoms are and about the advantages of making free choices to meet human needs.

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The human-rights approach is driven by a normative perspective on freedoms to meet human needs, the human-development approach by an action perspective on freedoms to meet human needs. Both perspectives place freedoms in the foreground and needs in the background. The complementary perspective in this paper reverses foreground and background by putting human needs on stage with human rights and human development in the wings. A need, that is “a deprivation that energizes a drive to eliminate or reduce the deprivation” (Van de Vliert 2009, p. 37), is considered fundamental if it applies to all human beings and seeks to redress a stressful deprivation of a basic freedom of choice. In terms of classic hierarchies of fundamental needs (Alderfer 1972; Maslow 1943), freedom from want satisfies immediate physiological needs, freedom from fear satisfies safety needs, freedom of expression and participation satisfies needs to relate to others, freedom from discrimination satisfies needs for esteem and respect, and freedom to develop and realize one’s human potential satisfies needs for self-actualization and personal growth.

More parsimoniously formulated in Alderfer’s (1972) trichotomy, fundamental freedoms satisfy existence needs (physiology, material safety), social needs (social safety, love, social esteem), and growth needs (self-esteem, self-actualization). Building on Kenrick et al.’s (2010) renovated hierarchy of fundamental needs, I propose that these needs and related freedoms are listed here in the order they are likely to first appear developmentally. The fact that existence needs, social needs, and growth needs are thought to be developed roughly in this sequence does not imply, though, that they fully replace each other. Rather, earlier-stage needs, complemented with later-stage needs, continue to be ready for activation by a wide variety of exogenous and endogenous cues. Notably, all fundamental needs drive collectives to adaptively respond to environmental necessities and opportunities in order to cope with deprivation stresses and increase freedoms of choice.

Section 2 in this target article proposes an explanation of geographic variations in collective freedom, which uses needs-based stress appraisals as conceptual linkages between climato-economic habitats and freedoms of choice. In section 3 I discuss methods for measuring climatic demands, monetary resources, and fundamental freedoms. Section 4 then applies this theory and methodology to analyzing freedoms while uncovering cross-national and cross-regional support for the existence of climato-economic origins of inequalities in fundamental freedoms. Special attention will be paid to freedom from discrimination because climato-economic theorizing can help clarify the causal order of ingroup favoritism and outgroup derogation in explaining large-scale conflict. In section 5, the climato-economic covariations of freedom in 2012 are used to cautiously forecast freedom in 2112 for 104 countries. Section 6 rounds off with discussions on theoretical implications, methodological concerns, and practical applications.

2. Climato-economic explanation of freedoms

The climato-economic theory of culture (Van de Vliert 2009; 2011a; 2011b; 2013) belongs to a family of demands-resources theories. Across the disciplines of

psychology (e.g., Bandura 1997; Lazarus & Folkman 1984; Skinner & Brewer 2002; Tomaka et al. 1997), sociology (e.g., Ormel et al. 1997), and the organizational sciences (e.g., Karasek 1979), it is widely believed that demands placed on people are a double-edged sword. Greater demands in interaction with insufficient resources to meet the demands increase closed-mindedness and risk aversion, whereas greater demands in interaction with sufficient resources increase open-mindedness and risk seeking.

Climato-economic theorizing similarly posits that the demands and the resources of the human habitat influence each other’s impact on the needs, stresses, and choices shared by inhabitants (*shared culture* is discussed in sect. 2.4.2). Greater climatic demands in interaction with poor monetary resources eventually promote avoiding ambiguity by making relatively unfree choices that are necessary and routine rather than autonomous and adventurous. Greater climatic demands in interaction with rich monetary resources eventually promote seeking ambiguity by making relatively free choices that are autonomous and adventurous rather than necessary and routine. This explanation of cultural management of ambiguity and free choice is presented here in subsections describing main effects of climatic demands, interactive effects of monetary resources, differential effects of cold and heat, and shared psychobehavioral adaptations.

2.1. Main effects of climatic demands

Like all warm-blooded species, humans have to maintain constant levels of high body temperature. In consequence, they have evolved a U-shaped dependence of body heat production or rates of metabolism on ambient temperature (Parsons 2003; Scholander et al. 1950). In an intermediate range of ambient temperatures, the thermoneutral zone, the metabolic rate required for the body to maintain a core temperature of approximately 37°C, is both minimal and independent of the ambient temperature. Below the thermoneutral zone, metabolism increases to generate enough heat (e.g., by shivering) for the body to maintain its temperature and survive. Above the thermoneutral zone, metabolism increases to support active cooling (e.g., by sweating or panting). Thus, the biological costs of maintaining body temperature and integrity increase on both sides of the thermoneutral zone.

The U-shaped dependence of heat production on ambient temperature equips humans with existence needs for thermal comfort, nutrition, and health (Rehdanz & Maddison 2005; Tavassoli 2009; Van de Vliert 2009). Temperate climates are relatively undemanding by offering thermal comfort, abundant nutritional resources owing to the rich flora and fauna, and comparatively healthy habitats. Colder winters and hotter summers require more and better clothing, shelter structures, and heating or cooling systems, increasing investments of time and effort in the pursuit of foods and drinks, and more measures to safeguard family health, also because acclimatization through long-term adjustment in anatomy and physiology has negligible compensating effects (Parsons 2003).

In sum, satisfying existence needs is progressively demanding in climates with increasingly colder-than-temperate or hotter-than-temperate seasons, thus creating more leeway for influence of the inhabitants’ resources

on their needs, stresses, and choices. Overlooking the interactive role of resources, Hippocrates, Ibn Khaldun, Montesquieu, Quetelet, and other classic scientists have all creatively tried to myopically and exclusively relate climate to culture (Feldman 1975; Sommers & Moos 1976). In a similar vein, at the beginning of the twentieth century, proponents of the geographical school have argued that climate straightforwardly determines health, human energy, mental efficiency, insanity, crime, and suicide (Sorokin 1928; Tetsuro 1971). Only gradually and recently have climate-culture researchers uncovered the complicating role played by money in collectively coping with climatic demands.

2.2. Interactive effects of monetary resources

Humans became more distinct from other warm-blooded animals when they started to obtain and store property. With the advent of agriculture, property became more important when people began keeping stores of food and domesticated animals. Property allowed trading. Trading led to the invention of money, which can be stored longer and more easily than agricultural products and creates more room for implementing free choice. Money has a crucial part to play also in coping with bitter winters and scorching summers (Parker 2000; Sen 1999; Van de Vliert 2009). Owning, saving, earning, buying, and selling can help prevent and dispel discomfort, hunger, thirst, and illness by satisfying existence needs. Liquid assets (cash) and illiquid assets (capital) can alter the effects of adverse winters and summers through investments in climate-compensating goods and services, including clothing, housing, heating and cooling, transportation, meals, and medical cure and care.

Thus, the greater biological costs of keeping alive and well on both sides of the thermoneutral zone can be compensated for by using cash and capital, in fact creating greater freedom of choice. Articulating the way this is visible in modern human communities, families in richer nations spend up to 50% of their household income on climate-compensating goods and services, a figure that rises up to 90% in poorer nations (Parker 2000, pp. 144–47). If more demanding winters or summers are insufficiently compensated for by the availability of monetary resources, detrimental consequences for psychobehavioral functioning, including unfree choices, eventually follow. If they are sufficiently compensated for by monetary resources, beneficial consequences, including free choices, follow. As briefly discussed next, two competing scientific principles color this picture differently: *theoretical parsimony* emphasizes that income-dependent consequences of harsher winters and summers are similar; *theoretical accuracy* emphasizes that those consequences are dissimilar.

2.3. Differential effects of cold and heat

Colder-than-temperate and hotter-than-temperate conditions pose divergent problems. Different hardships typically require distinct psychobehavioral adaptations (e.g., Cottrell & Neuberg 2005) and different uses of monetary resources as adaptational tools (Parker 2000; Sachs 2000; Sen 1999; Van de Vliert 2009). Money is more of a *sine qua non* for heating and eating in colder regions and months, but it is more for preventing and recovering

from diseases produced by substances, germs, bacteria, and insects in hotter regions and months. Also, money is not utilized identically when coping with frostbite, pneumonia, asthma, rheumatism, gout, influenza, and common colds in arctic conditions as compared to coping with malaria, yellow fever, schistosomiasis, trypanosomiasis, ochocerciasis, Chagas' disease, and filariasis in the tropics. Overall, as reflected in the World Bank's poverty lines (www.worldbank.org), life is a bit more expensive in cold compared with hot climates.

In this burgeoning phase of climato-economic theorizing, priority is given to parsimony over accuracy by emphasizing similarities rather than dissimilarities of the greater biological and financial costs of adaptations on the cold and hot sides of the thermoneutral zone (for less parsimonious and more accurate three-way interaction effects of winter demands, summer demands, and monetary resources on subjective well-being, self-expression, individualism, and democracy, see Van de Vliert 2009; 2013). Hence, throughout this article, psychobehavioral adaptations at the population level are parsimoniously traced back to only three types of habitats: (a) demandingly cold or hot habitats with poor monetary resources, (b) undemanding temperate habitats in poor or rich areas, and (c) demandingly cold or hot habitats with rich monetary resources.

2.4. Shared psychobehavioral adaptations

2.4.1. Primary and secondary appraisals.

Demands-resources theories state that humans continuously appraise their environmental situation with respect to its significance for well-being (e.g., Drach-Zahavy & Erez 2002; Lazarus & Folkman 1984; LePine et al. 2004; Skinner & Brewer 2002; Tomaka et al. 1997; Van de Vliert 2009). *Primary appraisal* assesses to what extent the situation is stressfully demanding because needs cannot be satisfactorily met; *secondary appraisal* assesses to what extent a stressfully demanding situation is threatening or challenging given the available resources to meet the demands. In climato-economic theorizing, primary appraisals assess to what extent winters and summers are comforting or stressfully demanding; secondary appraisals assess to what extent stressfully demanding winters or summers are threatening or challenging given the monetary resources. Although threatening and challenging habitats are both more stressful than comforting habitats, subjective livability in threatening habitats is worse than in comforting habitats, whereas subjective livability in challenging habitats may be experienced as even better than in comforting habitats.

Appraisals as cognitive-affective adaptations to objectively threatening, comforting, or challenging habitats are almost indistinguishably integrated with choices in behavioral adaptations to these habitats. Needs-based stress appraisals and choices of goals, means, and outcomes are not interrelated in a strictly sequential way, but are assumed to be continuously and simultaneously in flux, converging into a pattern of psychobehavioral adaptations characteristic of the inhabitants of a given habitat. The embedded behavioral choices can be more or less necessary and routine, thus unfree, versus more or less autonomous and adventurous, thus free. The main target of section 2.4 is to propose needs-based stress appraisals as conceptual linkages between objective climato-economic

habitats and increasing freedoms of choosing goals, means, and outcomes in subjectively threatening, comforting, and challenging habitats, respectively.

2.4.2. Threat appraisals, comfort appraisals, and challenge appraisals. An important criterion for the primary appraisal of climatic comfort versus stress is the satisfaction of existence needs for thermal comfort, nutrition, and health. It is a broadly relevant criterion as unmet existence needs tend to proliferate into frustration of social needs and growth needs (Alderfer 1972; Herzberg 1966; Kenrick et al. 2010; Maslow 1943). In the absence of harsher-than-temperate climates, comfort appraisals will not motivate people much to give primacy to working for extrinsic satisfaction and meeting existence needs, nor to give primacy to working for intrinsic satisfaction and meeting growth needs (Van de Vliert 2009). In consequence, social needs may gain in relative importance and may be more easily comforted in more temperate climates.

A critically relevant criterion for the secondary appraisal of the available monetary resources to meet climatic demands is the purchasing power of one’s household income (Parker 2000; Sen 1999). The climato-economic theory proposes that climates with demanding winters or summers are appraised as threatening in poor populations but as challenging in rich populations (Van de Vliert 2009; 2011a; 2011b; 2013). Threat appraisals are thought to emphasize inevitable necessities in unfree choices, whereas challenge appraisals emphasize free choices inherent in stimulating opportunities and autonomous adventures. As a consequence, overall freedom may be expected to be relatively low in threatening habitats and relatively high in challenging habitats, both compared to

the intermediate baseline level of overall freedom in comforting habitats.

No matter how much focal attention processing is involved, habitat appraisals are collective in nature. Exposed to the same winters, summers, and standard of living, all inhabitants are assessing and discussing these living conditions frequently, and are gradually pushing and pulling each other toward a predominantly *shared culture*, defined here as a shared pattern of needs and stresses, and embedded goals, means, and outcomes at the place of residence. Leading cross-cultural psychologists (Hofstede 2001; House et al. 2004; Leung & Bond 2004; Schwartz 2006; Triandis 1995) view goals as manifestations of values, means as manifestations of agency beliefs, and outcomes as manifestations of behavioral practices and consequences. In addition to goals, means and outcomes, the underlying needs and stresses, too, are viewed here as elements of subjective culture that become patterned around a central theme into a *cultural syndrome* (Triandis 1995, p. 6). Figure 1 visualizes threat appraisals, comfort appraisals, and challenge appraisals as three central themes that link climato-economic habitats to broader cultural patterns of needs, goals, means, outcomes, and embedded fundamental freedoms.

Evidence for the ecocultural existence and construct validity of threat syndromes, comfort syndromes, and challenge syndromes may be inferred from the results of a secondary analysis of clustered data about mental ill-being (Fischer & Van de Vliert 2011). Across 58 countries, burnout, depression, anxiety, perceived ill health, and unhappiness appeared to be most prevalent in poor populations residing in climates with more demanding winters or summers (e.g., Iranians and Serbs), intermediately

<i>Thermal climate</i>	Cold or hot	Temperate	Cold or hot
<i>Climatic demands</i>	Demanding	Undemanding	Demanding
<i>Monetary resources</i>	Poor	Poor or rich	Rich
	↓	↓	↓
<i>Psychobehavioral adaptations</i>			
<i>Needs</i>	Existence needs ¹	Social needs	Growth needs ⁵
<i>Stresses^a</i>	Threat appraisals ^{1,2}	Comfort appraisals	Challenge appraisals
<i>Goals</i>	Survival goals ^{1,2}	Easygoing goals	Self-expression goals ³
<i>Means</i>	Ingroup agency ⁴	Convenient agency	Individual agency
<i>Outcomes</i>	Autocratic organizing	Laissez-faire	Democratic organizing ⁵
<i>Fundamental freedoms</i>	Low	Intermediate	High

^a Primary appraisal assesses to what extent winters and summers are comforting or stressfully demanding; secondary appraisal assesses to what extent stressfully demanding winters and summers are threatening or challenging given the monetary resources.

Numbered notes indicate proposed relevance of an adaptation for a particular freedom:

1 = freedom from want – to enjoy a decent standard of living

2 = freedom from fear – with no threats to personal security

3 = freedom of expression and participation

4 = freedom from discrimination – by race, ethnicity, gender, religion, etc.

5 = freedom to develop and realize one’s human potential

Figure 1. Shared psychobehavioral adaptations to three types of climato-economic habitats, and embedded fundamental freedoms.

prevalent in populations residing in undemanding climates irrespective of income per head (e.g., Hongkongers and Sri Lankans), and least prevalent in rich populations residing in climates with more demanding winters or summers (e.g., Finns and Swiss). This pattern of findings is elegantly compatible with threat appraisals, comfort appraisals, and challenge appraisals as thematic categorizations of the cultural syndromes in Figure 1.

2.4.3. Survival goals, easygoing goals, and self-expression goals. Stress appraisals activate objectives varying on a bipolar continuum from *closed-minded* goals (aimed at avoiding ambiguity by making unfree choices that are necessary and routine) to *open-minded* goals (aimed at seeking ambiguity by making free choices that are autonomous and adventurous) (Gelfand et al. 2011; LePine et al. 2004; Richter & Kruglanski 2004; Ryan & Deci 2011; Schaller & Murray 2008; 2011). Threat appraisals activate closed-minded goals, comfort appraisals activate neither closed-minded nor open-minded goals, and challenge appraisals activate open-minded goals. Isomorphically, over extended periods of time, climato-economic threats are thought to promote closed-minded repression of free choices; comfort appraisals of nearly thermoneutral climates are expected to evolve neutral-mindedness and negligible effects on making free choices; and climato-economic challenges are thought to promote open-minded reinforcement of free choices.

As elaborated in earlier publications (Van de Vliert 2007; 2009), closed-mindedness, neutral-mindedness, and open-mindedness may be conceptually integrated with the World Values dimension of survival versus self-expression cultures. Figure 1 projects closed-mindedness into survival goals (left pole), neutral-mindedness into easygoing goals (midpoint), and open-mindedness into self-expression goals (right pole). The ecocultural validity of this three-part dimension of collective goal setting is apparent from the finding that poor populations in demanding climates pressurize themselves with closed-minded goals of formalization and centralization, whereas rich populations in demanding climates pressurize themselves with open-minded goals of informality and decentrality; by contrast, poor and rich populations in undemanding climates enjoy relatively pressure-free goals in between these two extremes (Van de Vliert 2009; 2013).

2.4.4. Ingroup agency, convenient agency, and individual agency. Of course, goals can be reached in multiple ways using multiple means. A crucially important issue is whether people give primacy to achieving goals by means of their own groups or by means of oneself, that is, whether they are collectivist, individualist, or a mixture of both (Brewer & Chen 2007; Gelfand et al. 2004; Hofstede 2001; Triandis 1995). Choosing ingroup agency is in essence creating positive discrimination and negative discrimination at the same time by treating ingroups more favorably than outgroups. Each choice of ingroup agency destroys some future freedom to ignore ingroup interests or to give outgroup interests priority over ingroup interests. By contrast, choosing individual agency is in essence creating some freedom from both ingroups and outgroups in favor of some personal freedom to act as one chooses. Conveniently adopting mixed agency is a third possibility; a telling example is the use of ingroup cooperation against

an outgroup to create joint gains in order to subsequently claim these ingroup gains individually (Van de Vliert 2013).

Continuous choices between relatively unfree ingroup agency and relatively free individual agency, or a mixture of both, may be expected to be influenced by the environment. Existential threats such as climatic and economic hardships set in motion collective processes of culture building in directions of closed-mindedness, ingroup commitment, and ingroup favoritism, whereas the opposite processes endow people with a high enough degree of open-mindedness “to venture out on their own into the ambiguous, uncertain, and often risky realm of individualism” (Richter & Kruglanski 2004, pp. 115–16). Gelfand et al. (2011), for example, have provided evidence that greater environmental threats and a greater dearth of resources promote cultural tightness with clearer norms and stronger sanctions for nonconformity, which are characteristic also of collectivist societies (Carpenter 2000; Triandis 1995).

From a sociopolitical perspective, Inglehart and Welzel (2005) similarly sketch close empirical associations between survival goals, ingroup orientation, and low freedom; and between self-expression goals, individual orientation, and high freedom. Integrating these findings with the above climato-economic explanation of culture, I expected collectivistic ingroup agency to be most prevalent in poorer societies with threatening winters or summers, somewhat prevalent in poorer and richer societies with comforting climates, and least prevalent in richer societies with challenging winters or summers. The reverse prediction holds for individual agency. In Figure 1, mixtures of ingroup agency and individual agency expected for inhabitants of undemanding climates are termed *convenient* as they will be suited to particular circumstances other than the climato-economic environment.

2.4.5. Autocratic organizing, laissez-faire, and democratic organizing. In his classic book on obedience to authority, Milgram (1974, pp. 123–24) has convincingly argued that “the formation of hierarchically organized groupings lends enormous advantage to those so organized in coping with dangers of the physical environment.” Indeed, in threatening circumstances, such as climato-economic hardships, “group members’ need for closure may soar and a group culture will emerge that centers around an autocratic leadership” (Richter & Kruglanski 2004, p. 113). By striking contrast, the cultural syndrome of open-mindedness, self-expression goals, and individual agency, which characterizes challenging climato-economic habitats, provides a “social force that operates in favor of democracy, helping to establish democracy where it does not yet exist, and strengthening democracy where it is already in place” (Inglehart & Welzel 2005, p. 299).

In Figure 1, mid-range outcomes between autocracy and democracy are expected to typically occur in comforting climato-economic habitats. Building on leadership work (Alvesson & Sveningsson 2003; Hinkin & Schriesheim 2008), these outcomes are labeled *laissez faire*, which should not be misunderstood as passively doing and achieving nothing. Laissez-faire in this case should be understood as actively choosing mixed outcomes because it is impossible for people to suppress hundreds of autocratic and democratic reflexes and actions, because punishments and rewards are often minimized on purpose, and

because laissez-faire choices reflect appropriate responses to low tides of necessities and opportunities in undemanding climates.

2.5. Conclusion

Climato-economic theorizing proposes that (a) shared primary appraisals of climatic demands assess to what extent winters and summers are stressful; (b) shared secondary appraisals of monetary resources assess to what extent existence needs are threatened, social needs can be comforted, and growth needs are challenged; and (c) adapted action streams of goals, means, and outcomes covary with shared degrees of fundamental freedom. Freedom is expected to be lowest in poor populations threatened by demanding winters or summers, intermediate in poor and rich populations comforted by undemanding temperate climates, and highest in rich populations challenged by demanding winters or summers.

3. Measuring climatic demands, monetary resources, and fundamental freedoms

3.1. Level of analysis

Shared psychobehavioral adaptations to climatic demands and income per head require a higher than individual or small-group level of analysis. Accordingly, all studies reported in section 4 are regressions at the level of countries, with the exception of cross-regional examinations of differences in discrimination within China and within the United States.

3.2. Climatic demands

The average temperature in a nation has typically been used as a predictor of local culture (e.g., Georgas et al. 2004; Hofstede 2001; House et al. 2004). But this seems insufficiently accurate as such averages (a) neglect the existence of a thermal optimum (4°C and 40°C both pose existential problems), (b) overlook the impact of year-round variations in temperature (small and large differences between winters and summers may have the same average), and (c) are negatively correlated with year-round variations in temperature (higher latitudes have both lower averages and larger variations). Viewed through a human-needs lens, an appropriate indicator of a country's climatic demands should therefore take account of winter and summer deviations from a biologically optimal point of reference.

As has become customary in this burgeoning line of research, 22°C (about 72°F) is adopted as a point of reference for optimal climatic livability, not only because 22°C is the approximate midpoint of the range of comfortable temperatures (Parsons 2003), but also because existence needs for nutrition and health are met more easily in temperate climates varying around a base range of, say, 17°C to 27°C (Cline 2007; Fischer & Van de Vliert 2011; Parker 2000; Tavassoli 2009). Climates are more demanding to the extent that their winters are colder than 22°C and their summers hotter than 22°C. Climatic demands are operationalized across each country's or region's major cities, weighted for population size, as the sum of the absolute deviations from 22°C for the average lowest and highest

temperatures in the coldest month and in the hottest month (source: Van de Vliert 2009). Mongolia, for example, with its cold winters ($| -44^{\circ}\text{C} - 22^{\circ}\text{C} | + | 1^{\circ}\text{C} - 22^{\circ}\text{C} | = 87$), and hot summers ($| -6^{\circ}\text{C} - 22^{\circ}\text{C} | + | 36^{\circ}\text{C} - 22^{\circ}\text{C} | = 42$), has a *climatic-demands* score of 129. Winter demands and summer demands worldwide have identical medians ($Mdn = 25$), and only slightly different means ($M = 30$ for winters; $M = 24$ for summers) (Van de Vliert 2009).

Criticisms of this measure include the neglect of precipitational climate and 22°C as a questionable point of reference for temperate seasons. However, rainfall and snowfall do not appear to alter the impact of thermal climate on culture, and somewhat lower or higher reference points than 22°C always yield almost identical research results (Van de Vliert 2007; 2009). The climatic-demands index has also been criticized because of the inadequacy of a single score for large countries spanning multiple climatic subzones. But adjusting for error-inducing temperature variations within nations, or even excluding large countries, strengthens rather than weakens the effects (Fischer & Van de Vliert 2011; Van de Vliert 2009; 2011a; 2011b). Consequently, the empirical results in section 4, which refer to both smaller and larger countries, may be interpreted as conservative estimates of support for the climato-economic theory.

3.3. Monetary resources

Income per head is measured with reference to the capacity of a country's currency to buy a given basket of goods and services (purchasing power parity in Geary-Khamis dollars, log transformed to reduce the skewed cross-national distribution; source: United Nations Development Programme 2004). Monetary resources and climatic demands are negligibly overlapping predictors of freedom ($r = .37$, $n = 175$, $p < .001$; Van de Vliert 2011a), thus minimizing the potential problem of multicollinearity.

3.4. Fundamental freedoms

Guided by the theoretical framework in Figure 1, the gist of low, intermediate, and high levels of fundamental freedom is captured with mutually overlapping measures of *needs* (existence vs. growth), *stresses* (threats vs. challenges), *goals* (survival vs. self-expression), *means* (ingroups vs. individuals), and *outcomes* (autocratic vs. democratic). To guarantee that regression estimates of freedom reflect a shared reality within each population, aggregations of individual-level measures are used only in case of significant differences between groups.

4. Climato-economic covariations of freedom

4.1. Freedom from want: To enjoy a decent standard of living

Freedom from want emphasizes that humans are not sticks or stones but a warm-blooded species that survives by ceaselessly satisfying existence needs. In human-rights and human-development activities, freedom from want refers to the absence of homelessness, malnutrition and underweight, lack of access to safe water, inadequate sanitation, and early mortality (Sen 1999; United Nations

Development Programme 2000; 2002; 2004). Infant mortality as a core indicator of broader societal misery, including child labor and school absenteeism, is highest in the poorest countries with the hottest climates (e.g., Central African Republic, Chad, Guinea-Bissau, and Niger). Main effects of heat demands (12%) and poverty (32%), together with interaction effects of heat demands and poverty (19%), account for 63% of the cross-national differences in under-5 mortality (Van de Vliert 2009). Child misery is much lower in poor and rich countries with undemanding climates; negligible, in rich countries with demanding climates.

These figures are in general agreement with the adaptations of needs, stresses, and goals to climato-economic habitats visualized in Figure 1. Yet, they fail to empirically confirm the pivotal notion that enjoying a decent standard of living predicts enjoying freedom of choice. Gallup World Poll data reported by the United Nations Development Programme (2010) do indicate that populations satisfied with their financial standard of living tend to be also satisfied with their freedom of choice ($r = .66$, $n = 137$, $p < .001$). But unknown is whether, in support of climato-economic thinking, this relationship is weaker in undemanding climates than in demanding climates. This I checked by examining the breakdown correlations for objectively threatening, comforting, and challenging habitats.

Satisfaction with the financial standard of living appears to predict satisfaction with freedom of choice better in poor populations threatened by demanding thermal climates ($r = .69$, $n = 46$, $p < .001$), and in rich populations challenged by demanding thermal climates ($r = .79$, $n = 46$, $p < .001$), than in populations comforted by undemanding climates irrespective of income per head ($r = .46$, $n = 45$, $p < .01$; $z = 1.57$, $p < .058$ for .69 versus .46; $z = 2.63$, $p < .004$ for .79 versus .46). These differences are compatible with the line and direction of thought. Monetary resources creating freedom of choice tend to be more critical and influential in habitats where either existence needs or growth needs are under stress, than in more comforting habitats where existence needs and growth needs are relaxed, allowing social needs to elbow to the fore.

4.2. Freedom from fear: With no threats to personal security

No other aspect of human security is as vital as freedom from fear of death of oneself or one's beloved (cf. infant mortality in sect. 4.1). But the Universal Declaration of Human Rights does not stop there: "No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment" (Article 5). As a member of the Bergen Bullying Research Group, I have participated in two climato-economic studies of international violations of this broader human right to freedom from mistreatment. Bullying as an infringement of personal security refers to protracted social conflict whereby a more powerful perpetrator persistently harasses, attacks, arrests, or even kills a less powerful victim, who perceives to have little recourse to retaliate in kind (Einarsen et al. 2011).

In the first study, Ståle Einarsen, Morten Nielsen, and I (Van de Vliert et al. 2013a) measured and analyzed harassment among 44,836 employees from 44 countries. Highly significant parts of the variations in 22 ratings of exposure to being ignored, humiliated, ridiculed, or intimidated

(1 = *never*; 2 = *now and then*; 3 = *monthly*; 4 = *weekly*; 5 = *daily*) were the result of country residency. Stronger support for the climato-economic predictions of stresses was found for more severe harassment acts. Notably, even with societal collectivism controlled for, climatic demands (0%), monetary resources (6%), and their interaction (13%) still accounted for 19% of the cross-national variation in "threats of violence or physical abuse or actual abuse." Victims of these threats and abuses were most prevalent in poor populations threatened by demanding thermal climates, moderately prevalent in populations comforted by undemanding climates irrespective of income per head, and least prevalent in rich populations challenged by demanding thermal climates. The Gini coefficient of income inequality in a country, religious participation and value, and ethnic heterogeneity could not predict this pattern of results.

The second study addressed another of the world's vexing problems: that journalists in many places are murdered, imprisoned, censored, threatened, and similarly bullied. Reporters Without Borders (source: www.rsf.org) annually measures freedom from fear among press people in 155 nations. In 2005, 2006, and 2007, partner organizations in all continents and a network of more than 130 journalists and correspondents answered 50 questions, including the following: How many journalists and media assistants were ... murdered (5–15 points); murdered with the state involved (5 points per case); arrested or sent to prison (3–15 points); currently in jail and serving over a year of sentence for a media-related offence (3–20 points); physically attacked or injured (2–6 points); personally threatened (1–4 points)? How many media outlets were censored, seized, or ransacked (3–12 points)?

Using this crude press repression index, the climato-economic predictions of threats to survival were confirmed year after year (Van de Vliert 2011a). In the most recent year (2007), climatic demands (11%), monetary resources (17%), and their interaction (8%) accounted for 36% of the variation in press repression. Rival explanations in terms of state antiquity, past violence, communist past, population diversity (language, religion, ethnic), and societal inequality (income, gender, power) could be ruled out statistically. As illustrated in Figure 2, press people were bullied most in poor populations threatened by demanding thermal climates (e.g., China, Sudan, Turkmenistan, and Uzbekistan), to a moderate extent in populations comforted by undemanding climates irrespective of income per head (e.g., Barbados, Honduras, Singapore, and Seychelles), and least in rich populations challenged by demanding thermal climates (e.g., Canada, Estonia, Slovakia, and Sweden). From this narrower subject of press repression, I now turn to the broader issue of free expression.

4.3. Freedom of expression and participation

World Values Surveys researchers (www.worldvaluessurvey.org; Inglehart & Baker 2000; Inglehart et al. 2004) have found a bipolar dimension ranging from survival goals that meet existence needs to self-expression goals that meet growth needs. Self-expression values and goals emphasize that priority should be given to self-realization and quality of life over physical and economic security.

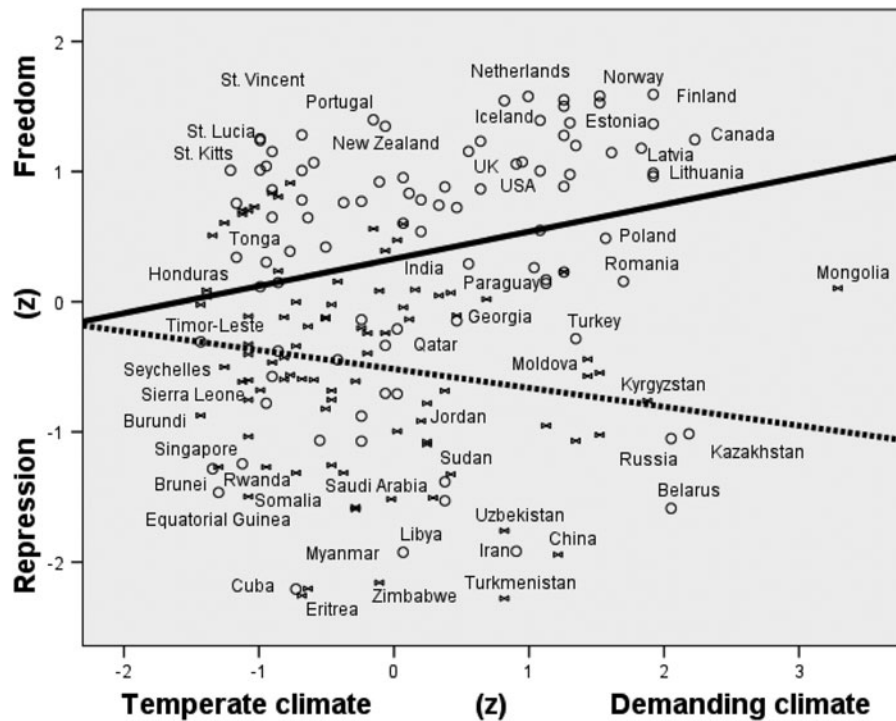


Figure 2. Opposite effects of climatic demands pushing and pulling toward press repression in poorer countries (bow ties and downward slope; $b = -.30, p < .001$), but toward press freedom in richer countries (circles and upward slope; $b = .27, p < .001$).

Individuals must have much control over their own life, including signing petitions and taking part in boycotts (Inglehart & Baker 2000). Clearly, “freedom of thought and speech and to participate in decision-making and form associations” (United Nations Development Programme 2000, p. 1) is minimal at the survival pole, moderate at the easygoing midpoint (see sect. 2.4.3), and maximal at the self-expression pole of the dimension of goal setting.

In common with international organizations, the World Values Surveys group assumes that poor societies endorse survival goals, whereas rich societies endorse self-expression goals. According to the framework of shared psychobehavioral adaptations to climato-economic habitats, this is an incomplete understanding of reality. Income differences are thought to be less relevant in undemanding climates. Additionally, colder-than-temperate and hotter-than-temperate climates are expected to increase the salience and valence of unfree survival goals in poor populations, but to increase the salience and valence of free self-expression goals in rich populations. The question whether survival goals, easygoing goals, and self-expression goals as a unidimensional proxy of repression versus freedom of expression and participation covary with climato-economic conditions was investigated in (a) a cross-sectional analysis of climatic demands and national income per head covering 77 countries, (b) a cross-sectional analysis of climatic demands and personal household income covering 66 countries, and (c) a longitudinal analysis of climatic demands and economic growth covering 38 countries.

In the first analysis, climatic demands (0%), monetary resources (52%), and their interaction (20%) accounted for 72% of the variation in survival versus self-expression goals (Van de Vliert 2009). As predicted, survival goals prevail in poorer populations threatened by more

demanding thermal climates (e.g., Armenians and Latvians); easygoing goals prevail in populations comforted by undemanding climates irrespective of income per head (e.g., Ghanaians and Singaporeans); and self-expression goals prevail in richer populations challenged by more demanding thermal climates (e.g., Canadians and Swedes).

The second analysis addressed the strength of the positive within-country correlations between personal household income and personal endorsement of the above goals for 62,172 wage earners in total. Only for members of poorer populations residing in more demanding thermal climates (e.g., Belarusians and Moldovans) did a person’s own household income make a difference: they appeared to endorse survival goals over easygoing goals and self-expression goals to the extent that they earned less ($R^2 = .42, p < .001$; Van de Vliert 2007). Apparently, higher household incomes push and pull people away from unfree survival goals and meeting existence needs, but do so only in miserable climato-economic habitats with considerable livability problems.

The longitudinal analysis (Van de Vliert 2009) looked at the annual percentage of change in goal setting, computed from 107,388 citizen responses during 8- to 19-year periods between 1981 and 2002. Again in support of the theory, even with national income controlled for, populations in more demanding thermal climates appeared to have moved more toward unfree survival goals to the extent that they were exposed to economic decline rather than economic growth ($R^2 = .59, p < .001$). As a noteworthy case in point, Estonians, Latvians, Lithuanians, and Russians all moved toward unfree survival goals after the collapse of communist rule and the subsequent economic decline—an average of minus 5% per year at the end of the twentieth century. Given the view of most theorists

that cultures are rather stable over time, this significant degree of covariation of climato-economic change and culture change is striking for the limited span of time investigated.

Taken together, national income, household income, and economic growth all seem to alter the link between climatic demands and goal setting in full agreement with the goal adaptations proposed in Figure 1. The analyses revealed that people residing in climates with more demanding winters or summers have no other choice but to endorse relatively unfree survival goals at the expense of moderately free easygoing goals and relatively free self-expression goals to the extent that their societies are economically deprived in terms of national income per head, household income, and economic growth.

4.4. Freedom from discrimination: By race, ethnicity, gender, religion, etc.

Positive discrimination or ingroup favoritism and negative discrimination or outgroup derogation tend to occur in tandem (Brewer 1999; Hogg 2007), which has inspired social psychologists to address the inherent problem of causality. “Findings from both cross-cultural research and laboratory experiments” seem to support the hypothesis “that much ingroup bias and intergroup discrimination is motivated by preferential treatment of ingroup members rather than direct hostility toward outgroup members” (Brewer 1999, p. 429; see also Halevy et al. 2012). If negative outgroup discrimination is, in many cases, an epiphenomenon of positive ingroup discrimination, it follows that a better understanding of ultimate roots of freedom from discrimination must be primarily sought in sources of ingroup favoritism.

At the population level, ingroup-outgroup discrimination is better known as ethnocentrism or, broader still, collectivism (Brewer & Chen 2007; Gelfand et al. 2004; Hofstede 2001; Triandis 1995). Collectivism is contrasted with individualism—a pattern of needs, stresses, goals, means, and outcomes that minimizes both positive ingroup discrimination and negative outgroup discrimination (see sect. 2.4.4). Single-factor explanations of cultural collectivism versus individualism have been sought in parasitic disease burden (Fincher & Thornhill 2012; Schaller & Murray 2011), voluntary settlement in frontier regions (Kitayama et al. 2006; 2010), and economic development (Inglehart & Baker 2000; Inglehart & Welzel 2005). Going beyond single-factor explanations, the climato-economic contextualization of collectivism versus individualism seeks to even better understand the inevitably complex phenomenon of societal variation in ingroup-outgroup discrimination.

The climato-economic theory predicts that (a) inhabitants of threatening habitats give more primacy to achieving goals by means of their own groups, often at the expense of other groups, (b) inhabitants of comforting habitats give more primacy to convenient mixtures of agency, and (c) inhabitants of challenging habitats give more primacy to achieving goals by means of oneself, thus less primacy to both ingroup favoritism and outgroup derogation. Note that greater climatic demands lead to more discrimination in poorer populations (upward slope) but less discrimination in richer populations (downward slope). These predictions were put to the test, first for ingroup discrimination

across 121 poorer and richer countries, then for upward sloping ingroup discrimination across regions within 1 large poor nation vis-à-vis downward sloping ingroup discrimination across regions within 1 large rich nation, and finally for outgroup discrimination across 85 poorer and richer countries.

4.4.1. Positive ingroup discrimination across countries.

The 121-nation study considered preferential treatment of members of the nuclear family, relatives at large, and fellow nationals. Middle managers’ participative observations of values and practices of familism ($n = 17,370$), top executives’ judgments of nepotism practices ($n = 10,932$), and citizens’ self-reported norms of compatriotism ($n = 104,861$) were analyzed. Familism, nepotism, and compatriotism were strongly expressed in poorer populations threatened by more demanding thermal climates, intermediately in poor and rich populations comforted by undemanding climates, and weakly in richer populations challenged by more demanding thermal climates (Van de Vliert 2011b; Van de Vliert & Postmes 2012). Climatic demands (4%), monetary resources (33%), and their interaction (10%) accounted for 47% of the variance in the composite index of ingroup discrimination, which appeared to peak in poor countries with cold winters and hot summers. Competing explanations having to do with state antiquity, language diversity, and ethnic heterogeneity were statistically excluded. In addition, longitudinal analysis offered no support for reversed causality.

4.4.2. Positive ingroup discrimination within countries.

The large number of rival predictors of familism, nepotism, and compatriotism arising from cross-national differences in state formation, demography, governance, etc., can be reduced by zooming in on a single country with many climatic regions. We therefore compared climate-discrimination relations across regions of a predominantly poor and collectivist country (China), and of a predominantly rich and individualist country (United States). Huadong Yang, Yongli Wang, Xiao-peng Ren, and I (Van de Vliert et al. 2013b) administered a 14-item collectivism questionnaire to 1,662 Chinese, aggregated scores for the 15 provinces in which they lived and worked, and gathered data on climatic demands, income per head, population density, and percentage of minorities from publicly available sources. Collectivism scores for all 50 states of the United States were taken from Vandello and Cohen (1999); climatic demands across each state’s major cities (source: www.census.gov/compendia/statab) were averaged and then aggregated per state; and state-level indicators of income per head, population density, and percentage of minorities were retrieved from the same source.

The climato-economic theory predicts that more demanding regional climates will produce more positive ingroup discrimination across the 15 Chinese provinces as representations of relatively poor populations, but less positive ingroup discrimination across the 50 United States as representations of relatively rich populations. Inspection and comparison of the two panels of Figure 3 reveal that this is the case. Within China, greater climatic demands in more northern provinces are associated with more positive ingroup discrimination ($r = .86$); within the United States, greater climatic demands in more northern states are associated with less positive ingroup discrimination

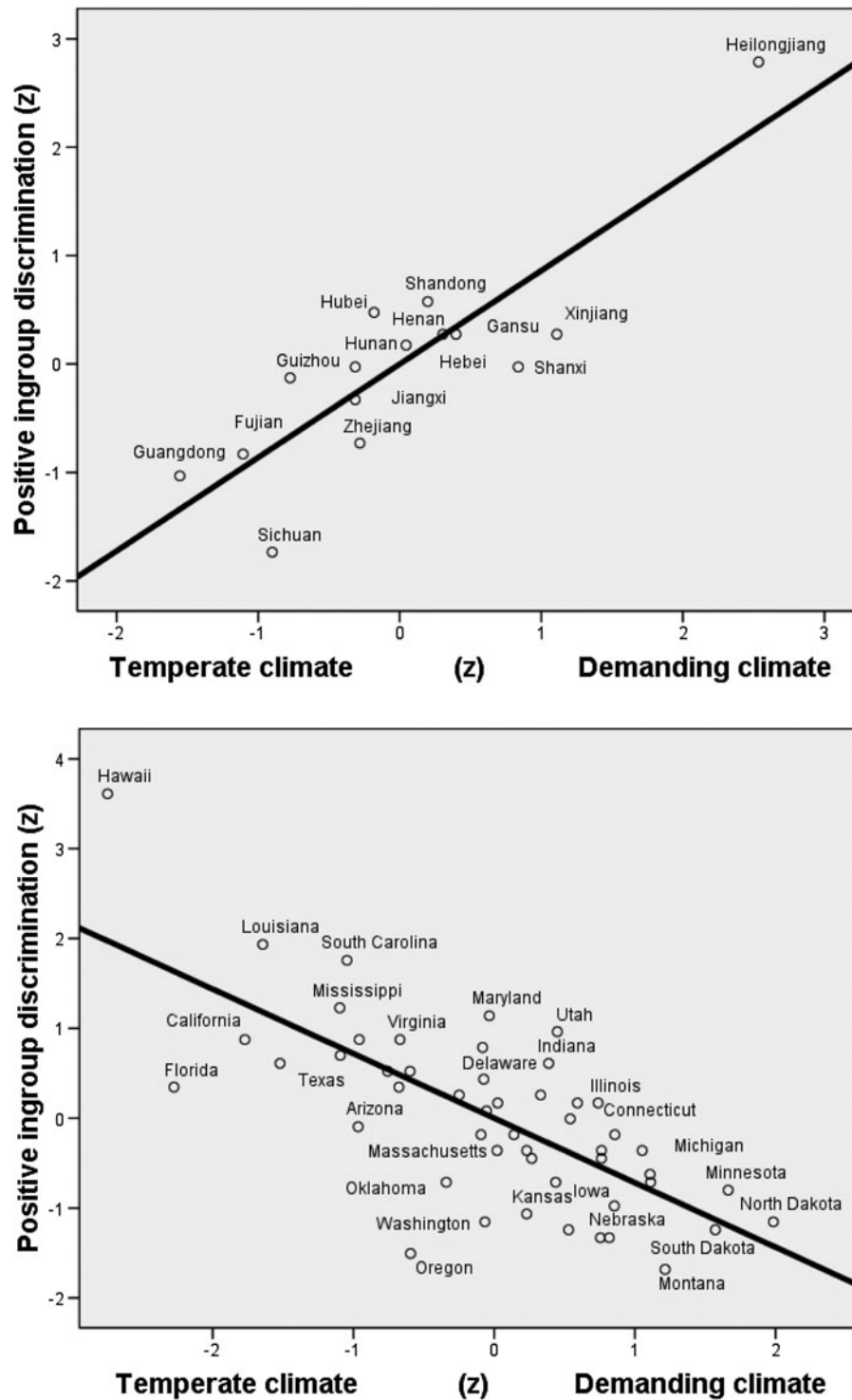


Figure 3. Opposite effects of climatic demands pushing and pulling toward positive ingroup discrimination within a poorer country (China; $r = .86, p < .001$), but against positive ingroup discrimination within a richer country (United States; $r = -.72, p < .001$).

($r = -.72$); and these significant opposite tendencies are significantly different from each other ($z = 6.80, p < .001$).

Multi-level analysis of the individual-level data from China further showed that positive ingroup discrimination is stronger in poorer Chinese provinces with more demanding thermal climates than in richer Chinese provinces with more demanding thermal climates. Controlling for the effects of gender, age, marital status, educational status, and professional status at the individual level, and population

density and minority percentage at the provincial level, did not change the results. However, when cultural collectivism at the provincial level was then entered into the equation, it appeared to be the only significant predictor, accounting for 17% of the individual-level variation. Apparently, exposed to the same winters, summers, and financial standard of living, residents of Chinese provinces are gradually pushing and pulling each other toward a shared culture—a collective rather than an individual process.

Obviously, multi-level analysis of the state-level U.S. data is impossible. A multiple regression analysis did reveal, however, that the negative impact of climatic demands on cultural collectivism in the 50 states is quite robust when controlling for rival predictors. Income per head ($\Delta R^2 = .02$, $b = -.80$, $p = .55$), population density ($\Delta R^2 = .04$, $b = .01$, $p = .23$), minority percentage ($\Delta R^2 = .60$, $b = .51$, $p < .001$), and climatic demands ($\Delta R^2 = .03$, $b = -3.26$, $p < .05$) accounted for 69% of the variation in cultural collectivism. Similarly, state-level personality differences ($\Delta R^2 = .11$; source: Rentfrow et al. 2008) in extraversion ($b = -.05$, $p = .63$), agreeableness ($b = -.06$, $p = .55$), conscientiousness ($b = -.10$, $p = .37$), neuroticism ($b = -.16$, $p = .06$), and openness ($b = .06$, $p = .52$), and climatic demands ($\Delta R^2 = .47$, $b = -8.15$, $p < .001$) accounted for 58% of the variation in cultural collectivism.

These findings allow four conclusions about the hypothesis that climato-economic habitats shape ingroup discrimination. First, the positive climate-discrimination link across poor countries also holds across regions within a poor country, which is home to the largest collectivist civilization on earth. Second, the negative climate-discrimination link across rich countries also holds across regions within a rich country, which is home to the largest individualist civilization on earth. Third, this two-nation replication (Fig. 3) of the results of the 121-nation study (sect. 4.4.1) minimizes rival explanations of the geographic spread of positive ingroup discrimination in terms of genetic make up, historical factors other than the climatic and economic past, language differences, religious heritage and diversity, educational and political regimes, and the like. Fourth, the opposite latitude-discrimination tendencies within two countries with similar latitudes do not support strongly latitude-related origins of positive ingroup discrimination, including magnetic field, average temperature level, seasonal cycles, day-night cycles, and parasitic disease burden.

4.4.3. Negative outgroup discrimination across countries.

Switching from ingroup discrimination to outgroup discrimination, I conducted a further analysis, the results of which are reported here for the first time. Outgroup discrimination was derived from the latest wave of the World Values Surveys (Inglehart et al. 2004; www.worldvaluessurvey.org). In face-to-face interviews covering 85 countries, at least 1,000 adults per country were asked: "On this list are various groups of people. Could you please sort out any that you would not like to have as neighbors? ... People of a different race ... Immigrants/foreign workers ... Homosexuals ... People who have AIDS ... People with a criminal record" (0 = not mentioned; 1 = mentioned).

For each outgroup category, the country percentages are listed in Electronic Supplement I. These five internally consistent indicators (Cronbach's $\alpha = .79$) were standardized and then averaged to represent the dependent variable of negative outgroup discrimination. Also listed in Electronic Supplement I are three predictor variables. Climatic demands and monetary resources served as independent variables (for their computation, see sect. 3). Ingroup discrimination (source: Van de Vliert 2011b) was included in order to better single out effects of threatening, comforting, and challenging habitats on outgroup derogation and ingroup favoritism. As might be expected, negative outgroup discrimination and positive ingroup discrimination are indeed entwined phenomena ($r = .57$, $n = 85$, $p < .001$).

As reported in Electronic Supplement 2, climatic demands (2%), monetary resources (35%), their interaction (5%), and ingroup discrimination as an epiphenomenal control variable (4%) account for 46% of the cross-national variation in discrimination of potential neighbors. Freedom from outgroup discrimination is weakest in poorer populations threatened by more demanding thermal climates, intermediate in populations comforted by undemanding climates irrespective of income per head, and strongest in richer populations challenged by more demanding thermal climates. However, when ingroup discrimination is first controlled for (33%), the climato-economic interaction term (1%) does not reach significance anymore, indicating that ingroup discrimination mediates the joint impact of climatic demands and monetary resources on outgroup discrimination.

When negative and positive discrimination change places, so that outgroup discrimination serves as a predictor of ingroup discrimination, the picture is different (see Electronic Supplement 2). With outgroup discrimination controlled for (33%), climatic demands (3%), monetary resources (7%), and their interaction (11%) continue to have their above-observed influence, indicating that outgroup discrimination does not mediate the joint impact of climatic demands and monetary resources on ingroup discrimination. Apparently, ingroup favoritism in real-life situations leads to outgroup derogation, rather than the other way round.

4.4.4. Interim conclusion on freedom from discrimination.

Taken together, the results of the three studies seem to support the propositions that (a) climato-economic hardships drive ingroup favoritism (as the model in Fig. 1 would have it); (b) ingroup favoritism in turn drives outgroup derogation (as Brewer 1999 and others would have it); and (c) individual agency tends to create freedom from both forms of discrimination (as sect. 2.4.4 would have it).

4.5. Freedom to develop and realize one's human potential

"Everyone has duties to the community in which alone the free and full development of his personality is possible." This sentence from the Universal Declaration of Human Rights implies that each human right generates a human duty to increase one's own and others' opportunities to be able to make and implement free choices of goals, means, and outcomes. Personal growth seems to have become an internationally endorsed ideal, whose realization may be obstructed by fear, repression, exploitation, discrimination, etc. The next paragraphs focus on intrinsically motivating work and democratic organizing because the preceding subsections have shed insufficient light on the international distribution of these relevant conditions of realizing people's potential.

Employees work for extrinsic reasons to meet existence needs and for intrinsic reasons to meet growth needs by achieving and learning things (Herzberg 1966; Kasser & Ryan 2001). The relative weights of extrinsic and intrinsic work motives vary not only from person to person, but also from population to population (Hofstede 2001; Inglehart et al. 2004; Lynn 1991). In a 38-nation study among 30,687 employees, I showed that managers, professionals, and

manual workers all tailor their reasons for working to their climato-economic habitat (Van de Vliert 2009). Extrinsic motives were represented by the option “A good income so that you do not have any worries about money”; intrinsic motives, by the option “Doing an important job which gives you a feeling of accomplishment.” Climatic demands (10%), monetary resources (36%), and their interaction (16%) accounted for 62% of the cross-national differences in work motivation. In support of the climato-economic prediction of existence needs versus growth needs, the relative weight of realizing one’s personal potential was lowest in the poorest countries with the coldest climates (e.g., Azerbaijan and Macedonia), intermediate in poor and rich countries with undemanding climates (e.g., Singapore and Tanzania), and highest in the richest countries with the coldest climates (e.g., Norway and Switzerland).

Turning from work motives to work management, the above pattern of results was replicated for autocratic versus democratic leadership in the target industries of food processing, financial services, and telecommunications services, using data from research into Global Leadership and Organizational Behavior Effectiveness (House et al. 2004). Climatic demands (4%), monetary resources (13%), and their interaction (14%) accounted for 31% of the variation in autocratic, mixed laissez-faire, and democratic leadership among more than 17,000 managers from over 900 organizations in 60 societies (Van de Vliert 2009). The perceived effectiveness of democratic leadership was lowest in poor populations threatened by demanding thermal climates, intermediate in populations comforted by undemanding climates irrespective of income per head, and highest in rich populations challenged by demanding thermal climates.

It is widely believed that democratic governance empowers people by helping them to realize their potential (United Nations Development Programme 2000; 2002). If so, civil liberties and political rights may reflect roughly the same cross-national distribution as democratic leadership in industrial organizations. To examine whether this is the case, one must go over a plethora of ratings of democratic practices across polities in terms of civil liberties, elections, party competition, citizen participation, and the like. As each of these measures has different strengths and weaknesses, Pemstein et al. (2010) used a Bayesian latent variable approach to synthesize the Unified Democracy Scores (UDS). We (Van de Vliert & Postmes 2012) chose the UDS over other indices because of the breadth of its domain, its reduction of measurement error, and its internal consistency (intercorrelations of the ten subscales range from .60 to .95; $M = .79$; $SD = .09$).

Across 174 nations, climatic demands (6%), monetary resources (22%), and their interaction (7%) accounted for 35% of the variation in autocratic versus democratic governance. Specifically, the interaction effect pictured in Figure 2 was replicated for the autocratic, mixed laissez-faire, and democratic outcomes in Figure 1, while controlling for parasite prevalence as a known predictor of democratization and liberalization (Thornhill et al. 2009). When the prevalences of human-to-human transmitted nonzoonotic diseases, animal-to-human transmitted zoonotic diseases, and their interaction, were first controlled for, climato-economic habitat still accounted for the largest part of the variation in democratic freedom ($\Delta R^2 = .21$; total $R^2 = .35$). However, when climato-economic habitat was first controlled for, parasitic disease burden could not

additionally account for any variation in democratic freedom ($\Delta R^2 = .00$; total $R^2 = .35$; Van de Vliert & Postmes 2012). Sociopolitical freedom necessary to meet needs for personal growth is lowest in poorer populations threatened by demanding thermal climates, intermediate in populations comforted by undemanding climates irrespective of income per head, and highest in richer populations challenged by demanding thermal climates.

4.6. General conclusion and evaluation

Accumulating evidence suggests that climatic demands are associated with degrees of fundamental freedom, but that these effects can be observed only if we distinguish between poor and rich populations. Across studies, climatic demands ($M = 5\%$) always accounted for considerably less variation in freedom than both monetary resources ($M = 27\%$) and the climato-economic interaction term ($M = 13\%$). All in all, repression of freedom is most likely in poorer populations that had to adapt to threatening colder-than-temperate or hotter-than-temperate climates, intermediately likely in poor or rich populations that had to adapt to comforting temperate climates, and least likely in richer populations that had to adapt to challenging colder-than-temperate or hotter-than-temperate climates. The strength that this conclusion is based on studies addressing different freedoms and using different samples and methods comes with the weakness that the results do not provide independent evidence. Rather, the results concern slightly different manifestations of overall freedom, loosely patterned around the central themes of threat appraisals, comfort appraisals, and challenge appraisals (for empirical evidence, see Electronic Supplement 3).

5. Projections of freedom in 2112

In section 4 we looked backward to create climato-economic equations that can predict levels of freedom. In section 5 we look forward by using these equations to model changes in freedom as a result of two huge threats humanity faces today: global warming and local poverty. The accuracy of predictions of freedom necessarily depends on the quality of climatic and economic forecasts, with the consequence that predictions need to be made carefully and that results should not be overinterpreted. Nevertheless, it would be foolhardy not to use insights from research on the recent past to make predictions of the further future that might help locate, diagnose, and potentially mitigate freedom-related problems. Therefore, the worldwide distribution of freedom in 2112 is estimated here for 104 relatively small countries listed in Electronic Supplement 4.B, for which both climato-economic projections and comparative freedom-data in 2012 are available for analysis.

5.1. Climato-economic simulations

The Intergovernmental Panel on Climate Change (IPCC 2001; www.ipcc.ch) has developed climatic and economic projections for the end of this century along the lines of four scenarios at the regional level. Scenario A1 emphasizes globalization and economic prioritization; A2, regionalization and economic prioritization; B1, globalization and environmental prioritization; and B2, regionalization and

environmental prioritization (see Electronic Supplement 4.A for details). Crossing the four temperature projections (A1, A2, B1, B2) with the four income projections (A1, A2, B1, B2) yields 16 classes of regional projections. However, as discussed next, more detailed country-level projections are available only for A2 temperature forecasts crossed with A1, A2, B1, and B2 income forecasts.

IPCC temperature projections, refined by the Center for Global Development (Cline 2007) and adopted here, have been detailed only for the worst climate scenario (A2) that does not play down global warming. Cline (2007) reported average temperature projections across six General Circulation Models. The expected average temperatures in the coldest and hottest months over the 2070–2099 period were used to compute the customary indicator of a country's climatic demands (see Electronic Supplement 4.B).

Projected monetary resources at the beginning of the twenty-first century, taken from Van Vuuren et al. (2007), are predictions of national income per head based on algorithms that take into account base year, relation between level of income and economic growth rate, regional income convergence, population size, and age profile of the population. Unlike the temperature projections, which are restricted to scenario A2, projections of national income per head are available for all four scenarios. In order to increase the accuracy of the predictions, each of the economic prospects under the scenarios A1, A2, B1, and B2 (see Electronic Supplement 4.B) were combined with the climatic prospect under scenario A2 to create four simulations of each country's climato-economic habitat by late in this century.

5.2. Assessment of freedom

5.2.1. Measured freedom in 2012. Freedom from positive ingroup discrimination (sect. 4.4.1), from press repression (sect. 4.2), and from political autocracy (sect. 4.5) were standardized and then averaged to represent overall freedom in 2012 (Cronbach's $\alpha = .87$). These indicators were chosen because each has strong climato-economic linkages ($R^2 = .47, .36, \text{ and } .35$, respectively), rests on at least three componential measures, and is available for more than 75% of the countries in the sample. Evidence for how well this cross-national index represents the nine indicators of current freedom reviewed in section 4 is presented in Electronic Supplement 3. Detailed information about the construction of the index is provided in Electronic Supplement 4.B.

5.2.2. Forecasted freedom in 2112. For each of the four climato-economic simulations (A1, A2, B1, B2), each country's three components of freedom in 2112 (discrimination, press repression, political autocracy) were predicted using the regression equations obtained (sources: Van de Vliert 2011a; Van de Vliert & Postmes 2012). Despite the differences between the four simulations, the four averages for discrimination, press repression, and political autocracy are not significantly different from each other (paired-samples tests, $t_s \leq \pm 1.27$, $df = 103$, $ps \geq .21$) and are highly intercorrelated (range $.87$ to $.97$; $M_r = .90$). The 12 estimates were therefore standardized and then combined into a single cross-national index of freedom in 2112 (for the index and its computation, see Electronic Supplement 4.C).

5.3. Relative changes in freedom: 2012–2112

To visually explore the existence of changes in freedom, measured freedom in 2012 was plotted against forecasted freedom in 2112. Because of the way they were constructed, the unstandardized indices approximated a standardized distribution, with the consequence that it made no difference whether unstandardized or standardized indices were plotted. In the plot with standardized indices, included as Figure 4, countries on the dotted diagonal undergo no relative changes in freedom; countries above or below the diagonal move up or down on the international ladder of freedom, respectively. Overall, a significantly hockey-stick-shaped curve of relative increases in freedom surfaced that accounted for 45% of the changes, and generally indicated that populations with little freedom in 2012 are expected to have moved up the ladder of freedom by the year 2112.

The left part of the curve in Figure 4 indicates that especially poor populations in Asia whose habitats will become less threatening will gain relative levels of freedom. The Turkmens, the Uzbeks, and the Kazakhstani, for example, will even surpass the Britons, the New Zealanders, and the Dutch in fundamental freedoms. The lower middle part of the curve predicts that Afghans and Pakistanis, and the great majority of Africans (e.g., Somalis, Nigerians, Burkinabe, and Sierra Leoneans) will lose rather than gain freedom. Unless climate protection and poverty reduction prevent this from happening, the relative demandingness of their climates increases without compensating increases in income. Finally, the right part of the curve visualizes the slightly worrying prospect of inhabitants of several rich countries who have to defend current freedom rankings against relative decreases in both climatic demands and monetary resources during the remainder of this century. In increasingly less challenging climato-economic habitats, their predispositions to freedom tend to weaken.

Self-evidently, these forecasts of freedom on the basis of estimates of climato-economic livability in 100 years from now are informed guesses at best. Freedom from discrimination, freedom from press repression, and freedom from political autocracy are influenced by multiple factors outside the IPCC scenarios, including unforeseen discoveries, major disasters, mass violence, and public health emergencies. What sections 4 and 5 do suggest, however, is that creeping changes in climato-economic habitats may well drive creeping changes in freedom, with the possible consequence that scientific engineering of freedom comes within reach, a topic to be discussed in section 6.3.

6. Theoretical implications, methodological concerns, and practical applications

6.1. Theoretical implications

The novel insight that climatic demands and monetary resources influence each other's impact on three patterns of needs, stresses, and freedoms goes beyond purely economic explanations of human culture (e.g., Halman et al. 2005; Inglehart & Baker 2000; Inglehart & Welzel 2005; Marx 1973; Sen 1999). In addition, this climato-economic explanation goes beyond mutually independent effects of climatic and economic conditions on human functioning

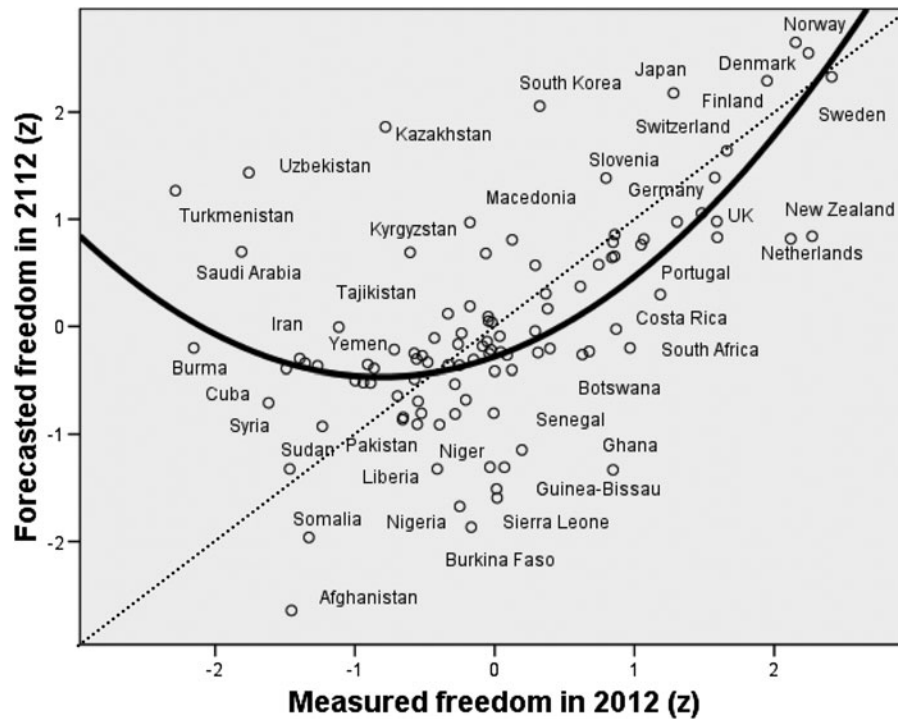


Figure 4. Relative changes in freedom between 2012 and 2112 forecasted for 104 countries on the basis of their climato-economic livability under current projections of global warming and economic development ($R^2 = .45$; $\Delta R^2 = .30$, $b = .46$, $p < .001$ for the upward linear component; $\Delta R^2 = .15$, $b = .28$, $p < .001$ for the U-shaped quadratic component).

advocated by adherents of the ecocultural framework (e.g., Berry 2011; Georgas et al. 2004). Finally, the theoretical matrix of demands, resources, and adaptations in Figure 1 also goes beyond earlier climato-economic works (Fischer & Van de Vliert 2011; Van de Vliert 2009, 2011a; 2011b; Van de Vliert & Postmes 2012) by organizing hitherto unorganized research results. The columns in Figure 1 interrelate and help explain needs, stresses, goals, means, outcomes, and freedoms in terms of climatic demands and monetary resources, whereas the rows systematically describe and compare threatening, comforting, and challenging habitats from six psychobehavioral viewpoints.

The climato-economic explanation of freedoms integrates dissociated areas of knowledge into an overarching perspective on psychobehavioral adaptations to ecological exigencies. The theoretical connections made between the U-shaped dependence of heat production on ambient temperature (biology), existence needs, social needs, and growth needs (psychology), primary and secondary appraisals of demands and resources (social psychology), and multiple components of freedom (sociology and politicalology) may generate new cross-disciplinary hypotheses and investigations. For example, a more refined explanation may be developed concerning the possibly differing impact of comfort appraisals by inhabitants of poorer and richer islands in the Caribbean on their easygoing goals, convenient agency, laissez-faire leadership and governance, and intermediate degrees of fundamental freedoms.

Coming back to ecological origins of inequalities in fundamental freedoms, psychobehavioral adaptations to climate are a sensitive subject given their history of single-factor determinism (Feldman 1975; Sommers & Moos 1976), even to the point of proposed effects of climate on the inferiority of some races (Huntington 1945; Taylor 1937). It is

therefore notable that climatic demands have negligible main effects on goals, means, and outcomes. Distancing oneself even further from climatic determinism, one could argue that creating freedom of action is inherent to all demands-resources theories (Bandura 1997; Karasek 1979; Lazarus & Folkman 1984; Ormel et al. 1997; Skinner & Brewer 2002; Tomaka et al. 1997). Indeed, resources are intelligently used to transform threatening constraints of demands into challenging freedoms of action, and transforming demanding and undemanding climato-economic habitats into levels of fundamental freedom, may well showcase the generalizability of this principle.

The further generalizability of cash and capital as adaptational tools for coping with environmental demands other than winters and summers may be an innovative avenue for future research as it continues to move us beyond single-factor determinism. Are there psychobehavioral adaptations to interactions of income per head and demandingness of, for example, natural disasters, nutritional deprivation, disease prevalence, population density, domestic political violence, or territorial threats from neighboring nations? Does the climato-economic explanation of needs, stresses, and freedoms survive tests against these alternative demands-resources interactions? If the climato-economic covariations of psychobehavioral functioning survive this kind of disconfirmatory testing, one next question is how climato-economic habitats are related to evolutionary processes.

Evolutionary biologists (e.g., Odling-Smee et al. 2003), psychologists (Baumeister 2005; 2008; Buss 2005; Kenrick et al. 2010; Plotkin 2002; Yamagishi 2011), and anthropologists (e.g., Boyd & Richerson 2005) may want to read section 4 as extra evidence for the validity of models of niche construction, that is, constructing a

stable set of needs-based stresses, goals, means, and outcomes within a given habitat. Cash and capital were gradually constructed as ingenious tools that exist independently of place, time, and items they can buy, thus increasing the ability to make and implement free choices. In turn, these tools are now intensively used to shape the environment by altering direct and indirect impacts of adverse winters and summers on meeting existence needs, social needs, and growth needs. All of these niche-construction activities might lead to new feedback cycles and become the basis for continuous further adaptation, as the recent financial crisis may have vividly demonstrated. In undemanding temperate climates, where life is relatively easy, monetary resources may be relatively unimportant for niche construction. In climates with demanding winters or summers, however, cash and capital seem to be indispensable tools for continuously trying to turn threatening habitats into challenging habitats.

6.2. Methodological concerns

In an ideal field experiment, one would randomly manipulate climatic demands and monetary resources in one hemisphere of the earth, use the other hemisphere as a control condition, and demonstrate that fundamental freedoms in the two hemispheres start to diverge as predicted by climato-economic theorizing. Convenience sampling of geographic areas and cross-sectional analysis of only the most recent climatic and economic histories cannot provide such proof of causality. Notably, remote exogenous resources may interact with climatic demands in producing confounding effects on monetary resources and through it on fundamental freedoms. Therefore, I made certain that geographic resources (see Electronic Supplement 5.A), natural land and marine resources (see Electronic Supplement 5.B), and natural security resources (see Electronic Supplement 5.C) do not have climate-dependent effects on monetary resources. Conversely, no evidence surfaced that fundamental freedoms as cultural resources interact with climatic demands in producing monetary resources (see Electronic Supplement 5.D on reverse causation).

As a result of treating independent countries as if they represent independent observations, there is also the risk that imaginary climatic, economic, and political boundaries between adjacent countries have biased the results by violating the statistical assumption of independence. This risk has been examined assuming that a country is more similar historically to other countries if it is sharing more physical borders with other countries (1 = *island*; 2 = *borders < coastlines*; 3 = *borders > coastlines*; 4 = *landlocked*; source: Parker 1997). Electronic Supplement 5.E shows that the impact of this kind of spatial dependence on overall freedom in 2012 ($\Delta R^2 = .05$) is dwarfed by the climato-economic impacts ($\Delta R^2 = .55$). The degree of spatial dependence does not seem to alter the initial conclusions about the interactive effects of climatic demands, monetary resources, and their interaction on freedom from discrimination, press repression, and political autocracy.

These supplementary analyses tentatively suggest that imperfections in the sampling and analyzing procedures have biased the results only to a negligible extent. The robustness of the climato-economic observations across freedom domains may also point toward a sufficiently solid theoretical and empirical foundation to support not

only further climato-economic theorizing, but also prospective thinking about strategic interventions for monitoring, forecasting, and improving freedom.

6.3. Toward scientific engineering of freedom?

This article opened with the predominant human-rights perspective of philosophers and lawyers (e.g., Donnelly 2006; Dworkin 1978; Kanger 1985), and the predominant human-development perspective of economists and political scientists (e.g., Inglehart & Welzel 2005; Sen 1999). The research results from my international team may make clear that scholars and practitioners with human-rights or human-development agendas could probably benefit from the existence of a complementary human-needs perspective. The findings in regard to freedom from discrimination seem to represent a case in point. Interventionists and politicians may want to put to use the novel insight that large-scale conflicts between groups tend to be a direct consequence of outgroup hate and an indirect consequence of ingroup love (cf. Brewer 1999; Halevy et al. 2012), which can both be partially linked back to the climato-economic hardships of the groups' habitat. Concerted implementation of climate protection and poverty reduction seems especially relevant for the predominantly tribal African and Asian communities clustered at the bottom of Figure 4.

The reported empirical evidence, illustrated with forecasts of freedom, seems to be leaning toward the following recommendation: To promote fundamental freedoms throughout the world, one has to empower people to generate more monetary resources if they are living in a more demanding climate. With the help of projections such as those in the Electronic Supplements 4.B and 4.C, and visualizations such as Figure 4, sociologists, psychologists, and biologists may want to enter into scientific debates on climate protection and poverty reduction led by colleagues from other disciplines who seem to be less reluctant than the psychobehavioral science community to take their informed guesses for the truth. Indeed, there may be a hitherto hidden ethical obligation for psychobehavioral scientists to contribute to realizing human-rights and human-development ideals.

As a rule, such engineering of freedom requires international investments and cooperation. By way of exception, leaders of four large countries are in a historically unique position to be able to successfully manage internal differences in climato-economic threats to freedom. Almost three billion people living in these so-called BRIC countries (Brazil, Russia, India, China) face painful inequalities in climatic demands, monetary resources, and fundamental freedoms. However, the rapidly growing BRIC economies enable the BRIC governments to gradually develop more threatening habitats into more challenging habitats. Electronic Supplement 6 suggests the cautious prediction that global warming in times to come would tend to harm climatic livability and related freedoms in northern Brazil and southern India unless local economic growth prevents this from happening. By contrast, global warming would tend to benefit climatic livability and related freedoms all over Russia (except the Caspian-Black Sea area), in Central China, and on the Tibetan Plateau unless local economic decline prevents this from happening.

6.4. Coda

Robust climato-economic covariations of fundamental freedoms raise a broad question for further investigation and possible intervention: In what domains, in what ways, and to what extent have psychobehavioral adaptations in humans, unlike evolution in animals and plants, contrived to integrate climatic and economic underpinnings?

SUPPLEMENTARY MATERIALS

Electronic Supplements 1 through 6 are available at <http://dx.doi.org/10.1017/S0140525X12002828>

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Open Peer Commentary

Interpersonal exchange and freedom for resource acquisition

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Abstract: The relationship of climate and monetary resources to various freedoms can be enriched if the conceptual links – “psychobehavioral adaptations” – are conceptualized more broadly as reflections of a richer cultural context that involves multiple physical and psychological resources, as proposed by social resource theory and a number of models of the emergence of social meaning.

Van de Vliert’s attempt to explain the relationship between fundamental needs and freedoms is a very promising effort, particularly because it emphasizes the role that the acquisition of resources plays in human culture. There is little doubt that climatic conditions and available resources lead to predictable cultural syndromes. Van de Vliert’s position is that the resources involved in various cultural syndromes or distinct cultural patterns are monetary. I believe that consideration of a richer context of human social exchange offers a deeper and more rounded view of human values and social meanings. This is acknowledged in the target article, as, for example, in the discussion of the variety of behavioral adaptations to different habitats. However, the emphasis is clearly on the relationship of climate and economic conditions to the rise of various kinds of freedoms, with “psychobehavioral” adaptations conceptualized as links between the two. I propose that these adaptations are reflections of additional resources that define psychologically various cultural habitats.

Human social exchanges involve much more than the transfer of monetary resources. Over the years, research on social resource theory has established that, across cultures, any social interaction involves the exchange of at least one of six major classes of resources: love, services, goods, money, information, and status (Foa & Foa 1974). The six classes vary in *concreteness* and

particularism (the extent to which the relationship between the persons engaged in the exchange is important for its satisfactory completion). Foa (1993) has pointed out that traditional approaches, which separated the economics from the psychology of human exchange, missed the point that any social interaction involves a combination of these resources. Consequently, any attempt to explain fundamental aspects of human social life must take into consideration the range of resources being exchanged. From this perspective, all freedoms studied in the target article can be understood as freedoms to acquire/exchange resources. Thus, for example, freedom from fear may involve the resource of love (affection/affiliation), freedom of expression may involve the resource of information, and freedom from discrimination may involve the resource of status (needs for esteem and respect).

I have incorporated aspects of social resource theory into a model of the emergence of cultural syndromes or patterns (Adamopoulos 1999; 2012). The fundamental assumptions behind this approach are (a) that all social interaction can be viewed as resource exchange and (b) that constraints operating on human interaction (e.g., whether the exchange is meant to benefit the self or the other, whether the relationship between actor and target is particularistic or universalistic, and whether the resource being exchanged is concrete or symbolic) are integrated into cultural patterns. Thus, for example, patterns that are oriented toward the benefit of generalized others and involve material resources give rise to values associated with benevolence, philanthropy, and altruism. These patterns have been described in individualism-collectivism theory (Triandis 1995), as well as in Schwartz’s (1992) theory of human values.

The processes identified via such a resource-based analysis of interpersonal exchange can help describe in detail the psychological “assessment” mechanisms assumed in the target article, and, more specifically, the “psychobehavioral adaptations” that link climatic conditions and monetary resources to fundamental freedoms. On the basis of such a multiple-resource approach, I would predict that maximal freedom would be found in cultures where typical social interactions involve the exchange of resources – especially material ones – in nonparticularistic (generalized other) relationships meant primarily to benefit the self. I have described such a cultural pattern as *ego-sustaining individualism* (Adamopoulos 1999). It is similar to Triandis’s (1995) *horizontal individualism* and may involve the primacy of values like *self-direction* and *stimulation* (Schwartz 1992).

A reexamination of the major predictions of the target article regarding the rise of fundamental freedoms in different climato-economic habitats in the context of such a multiresource model might suggest a set of different, interpersonal processes as links between the two. For example, in demanding climates with high levels of poverty, interdependence would be high. This would necessitate many controls (e.g., social norms) in order to regulate interpersonal relationships, and, hence, lead to low freedom. In temperate climates, the abundance of resources would not warrant great concern and competition for resource acquisition. At the same time, however, temperate climates also encourage ease and frequency of interpersonal exchanges, which most likely implies that at least some norms and regulations must be in place. Finally, in harsh climates many resources probably have been acquired through, and interpersonal interactions (e.g., trading) involve, considerable effort. Demand for limited resources would be high in such a context, along with a rise in advocacy for various freedoms (e.g., protests against high taxation, or the belief in the individual’s right to protect self and acquired resources by any means possible).

One related final point: the climato-economic model approaches the rise of fundamental freedoms from a rather individualistic point of view because of its emphasis on the acquisition of monetary resources. Note that in social resource theory money is the resource lowest in particularism (i.e., the other’s identity is not terribly important in completing the transaction in a satisfactory manner). I have suggested that there is

another perspective, however—that of benefitting the other through one's actions. This perspective is critical in understanding interdependent relationships in much of the world, but is largely ignored in the target article. Consider an example: according to Figure 1 in the target article, the central outcome of harsh climates with low monetary resources is autocratic organization with low freedom. Yet, there exist numerous communities around the world where communalism emerges in such conditions. Fiske (1991) describes such a community in Western Africa and makes the point that social organization is motivated by a desire in members of a village to work communally and help each other, rather than to maximize economic benefit. A careful analysis of the role of multiple resources in the organization of culture is, I believe, essential to understanding the emergence of social meanings and values.

Cold climates demand more intertemporal self-control than warm climates¹

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Abstract: A climate that is too cold to grow crops for part of the year demands foresight and self-control skills. To the extent that a culture has developed intertemporal bargaining, its members will have more autonomy, but pay the cost of being more compulsive, than members of societies that have not. Monetary resources will be a consequence but will also be fed back as a cause.

The target article reports the correlates – and putative causes – of the prevalence of five kinds of freedom, which Van de Vliert summarizes as the badge of advanced culture, autonomy: “Freedoms are defined here as opportunities to be able to make and implement autonomous choices of goals, means, and outcomes” (sect. 1, para. 2). In developmental literature, cultural advance is often equated with economic development and, as such, with specific historical factors, particularly investment, commercial expansion, scale effects, and technological knowledge (Mokyr 1990). There is obviously a considerable endowment effect in the geographical distribution of these factors, but from ancient times the assertion has been made that early endowments are related to coldness of climate, as in the “equatorial paradox” (no developed countries in low latitudes – Parker 2000, pp. 1–15). The assertion that climate is or was a major influence on development has become known as environmental determinism and has been dismissed in some quarters as Eurocentric (e.g., Blaut 2000). “Neo-environmentalist” attempts to use some of its observations in more nuanced models have met with something close to outrage (e.g., Radcliffe et al. 2010). Thus, in trying to reintroduce climate as a factor in cultural advance, the Van de Vliert understandably distances himself from the older determinists.

Van de Vliert's angle is that wealth interacts with climatic extremes to motivate cultural advance: Rich countries are challenged to grow by climatic problems, whereas poor countries are intimidated by these problems. However, his use of “monetary resources” as an independent variable is debatable, because wealth would seem to be as much an outcome of cultural advance as a determinant. It is true that wherever Van de Vliert reports what variance in a freedom is attributable to climatic demands and monetary resources, money outweighs climate, often heavily. But money is not a given resource, and its interaction with climate and with itself (as in money making money) must be internally complex. The role of money as an outcome is

neglected. It would have been good to know even how much of the variance in wealth was accounted for simply by climate, beyond the report that money and climate “are negligibly [sic] overlapping predictors of freedom” at $r = .37$ (sect. 3.3). In any case, the question of how countries might have been endowed with the monetary factor is left dangling.

Van de Vliert has taken some trouble to differentiate his other independent variable, “climatic demands,” from the equatorial paradox. However, although he describes these demands as arising on both sides of the “thermoneutral zone” (sect. 2.1, para. 1), all the countries that are named in the right-hand third of his Figure 2 or have positive climatic demand values in Electronic Supplement 1 are “demanding” because of cold seasons. He uses “temperate” oddly to describe such countries as Honduras, Somalia, and Equatorial Guinea (Fig. 2). If we accordingly take the main challenge of climate to be cold, there is a simple hypothesis that makes this challenge a factor in both economic and cultural advance: A climate that is too cold to grow crops for part of the year demands foresight and self-control skills, which then serve as resources for other development. Van de Vliert recognizes that the stress of cold is different from that of heat – a need for “heating and eating” versus tropical diseases (sect. 2.3, para. 1) – but does not point out that, until recently, self-control skills have had very little effect on the latter. In other words, climates that impose stress with limited growing seasons punish lack of foresight. Those that impose stress with endemic parasites and diseases have not done so until recently.

Van de Vliert's unique invention is to discern three clusters of cultures, rather than the conventional continuum: cold countries may be rich or poor, with a middle cluster of countries, rich and poor, unlike the countries at either extreme in that they are easygoing and “laissez-faire.” He relates the middle phenomenon to a lack of climatic demands, because “comfort appraisals will not motivate people much to give primacy to working...” (sect. 2.4.2, para. 1). This model has people simply adjusting their effort according to caloric need, which might not in itself be a great inducer of cultural development. I would argue that it is the alternation of seasons that demands self-control, a quantum leap in adaptation. Examination of the means of self-control evoked by climatic demand – that is, the challenge/threat of cold seasons – roughly supports the author's three-fold division, at least for cultures' historical roots when most people were subsistence farmers: a farmer who faces cold seasons must not only foresee their recurrence, but take steps to invest current effort in preparing for them. Conventional economics has always assumed that the foresight itself will evoke the necessary motivation, but motivational science has now caught up with common sense to discredit that belief (Ainslie 1992; Laibson 1997; Ross 2005). People innately overvalue the near future (as do nonhumans, whose long-term welfare depends on instincts). We do so not only for short periods of emotional arousal, but also in procrastinating and in many kinds of failure to invest (Ainslie 2012). In climates where long-term comfort – or survival – requires foreseeable periods of discomfort, a poor farmer must protect his seed corn from what he can expect to be dominant impulses to consume it. Foresight alone will not provide this protection; he must bring additional incentives to bear on his future self to oppose the foreseen impulses.

The simplest but least flexible means is for the farmer to submit to the authority of his “collectivistic ingroup agency” (sect. 2.4.4, para. 3), that is, to surrender much of his independence to external powers, as the climatically threatened poor are said to do. However, if his culture has taught him how to interpret individual choices as test cases predicting series of his own future choices, he may recruit the needed incentive by intertemporal bargaining: He can perceive his long-term prospects to be at stake at each move in a variant of a repeated prisoner's dilemma game with his future selves. He can thus develop personal willpower, the key component of autonomy. I have argued elsewhere that this is also the mechanism of the Protestant ethic (Ainslie 1992, pp. 203–205), which has been said to promote that powerful developmental force, market capitalism (Weber 1904/1958).

The intertemporal bargaining solution is not without cost. To the extent that people make choices on the basis of their self-signaling value, they will become lawyerly with themselves, dry, rule-bound, compulsive. People who have not encountered a great need for self-control—such as Van de Vliert’s climatically unstressed group—may experience adepts at willpower as cold and socially distant, not models they want to emulate. Granted, winters are less dangerous now than they were in historical times. It may still be that “families in richer nations spend up to 50% of their household income on climate-compensating goods and services [and 90% in poor ones]” (sect. 2.2, para. 2), but these goods have a large component of roominess, privacy, taste, and style. Nevertheless, winters still punish the unprepared, a risk that denizens of warm climates can afford to ignore. The climate factor must certainly still be added to the multifarious other incentives that bear on self-control and determine peoples’ “cultural syndromes” (sect. 2.4.2, para. 4).

NOTE

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How is freedom distributed across the earth?

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Abstract: Although Van de Vliert presented an entertaining story containing several original observations, an implicit assumption that climate affects human society identically through the history is not realistic. If almost everything is explained by cold winters or hot summers, then nothing is explained. Ignoring rival explanations does not make the proposed theory more convincing.

As Van de Vliert rightly claims, freedom is very unevenly distributed across the earth. But so unfairly is distributed almost everything that is important to human life: literacy, wealth, life expectancy, and even mental abilities. Although it is almost impossible that distribution of these complicated concepts replicates even partially the distribution of climatic warmth, Van de Vliert argues that cold winters and hot summers shape human minds and direct people’s behavior.

Van de Vliert has done admirable work to convince readers that almost everything from charismatic leadership (Van de Vliert 2006) to driving performance (Daanen et al. 2003) is determined by climate. In Isaiah Berlin’s terms, Van de Vliert is evidently a hedgehog who knows a lot about climate and its influence on human mind. Although not even De Montesquieu (2011/1748) thought that climate determines everything in human nature and society, Van de Vliert tries to convince readers that climate with its immanent presence is the most powerful factor. Because a variety of phenomena are probably influenced by ambient annual temperature, the most demanding task is to establish the exact causal chain from temperature to the observed consequence among myriad other competing factors. This is not an easy task, and there are many hurdles to accomplish this mission. Neither historians nor social scientists are particularly advanced in assessing relative causal importance of multiple factors that could affect the observed phenomenon (Pork 1985).

In early stages of development, both hominids and the society they created were certainly very vulnerable to all climatic deviation from the comfort zone. It seems that bipedalism in early hominids emerged from the necessity to cool the brain in response to heat stress (Falk 2004). It is also very likely that the development of human society was constrained by climatic conditions and especially by ambient temperature. However, with the development of technology, more and more people in advanced societies spent most of their time in an artificially created room climate, irrespective whether the outside temperature is below zero or more like a Finnish sauna. It is expected that with the development of wealth the pressure from climato-economic factors will start to diminish. Therefore, it is not surprising that self-reported mood is practically independent of hourly weather conditions (i.e., temperature, barometric pressure, humidity, and luminance) even in demanding Nordic climatic conditions (Kööts et al. 2011). In the view of all these evidences, it is slightly embarrassing that the picture of climatic determinism drawn by Van de Vliert is fully static without any traces of history.

Van de Vliert treats freedom extremely holistically. It is rather unrealistic to assume that, for example, “freedom from want” belongs to the same category as “freedom of expression and participation.” If we unite many different concepts under the same heading, then there is no guarantee that these entities have in fact anything in common. For example, it does not make much sense to put the need of food into the same category as freedom from religious prosecution (“freedom from discrimination”). Giving them an arbitrary common name (“freedom”) does not make them identical in any meaningful way. Because so many disparate things are collected into one heading, the proposed theory obviously loses, rather than gains, its explanatory strength: if almost everything is explained by cold winters or hot summers, then nothing is explained.

It is needless to say that many things are not affected by cold or heat stress. For example, it is very likely that metaphorical thinking that describes friendly people as warm, passionate people as hot-blooded, and distant people as cold in English and many other languages may also shape national stereotypes. Nevertheless, Pennebaker and colleagues (1996) tested De Montesquieu’s (2011/1748) hypothesis that hot weather makes individuals relatively lazy, pleasure seeking, and impulsive. They found only modest support for this provocative hypothesis. Later studies also found little support for the proposal that the aggregate personality traits (e.g., the facet of Extraversion called E1: Warmth) is related to mean annual temperature of these places where people habitat (McCrae et al. 2007). The only replicable finding that related country aggregate personality scores to temperature was that members of nations with warmer climates were higher, rather than lower, on conscientiousness (Allik & McCrae 2004). However, national stereotypes in a sample of 49 cultures, which generally do not reflect actual differences in the mean level of personality traits (Terracciano et al. 2005), supported a stereotype that people from physically warm environments are thought to be friendly, whereas a chilly climate makes people more business-like and cold (McCrae et al. 2007).

It is true that Van de Vliert sometimes tested rival explanations in terms of a country’s historic roots, population diversity, or societal inequality (e.g., Van de Vliert 2011a). Surprisingly Van de Vliert does not mention series of books written by Richard Lynn and his collaborators. The scope of Lynn’s work is very similar to the aims of the target article. For example, the “IQ and global inequality” tries to explain human inequalities by the concept of cognitive abilities (Lynn & Vanhanen 2006). Looking at the list of observed inequalities, it is immediately clear that this list is overlapping with Van de Vliert’s list of freedoms. Among other things, Lynn and Vanhanen (2006) also consider the impact of latitude and annual mean temperature on human inequalities. As expected, latitude has a substantial impact on the quality of human life. However, the authors conclude that “the impact of latitude and annual mean temperature on the

quality of human conditions takes place principally through national IQ, which is the intervening variable in the relationship between geographic and climatic factors and the quality of human conditions.” (p. 181).

Many readers most likely disagree with Lynn and Vanhanen’s (2006) conclusion that psychometrically measured intelligence is the prime factor of human inequalities and fundamental freedoms. But it is unfair to ignore this as a rival explanation because it was proposed that survival in cold geographical environments exerted a strong selection pressure on human populations (Lynn 1997).

Press freedom, oil exports, and risk for natural disasters: A challenge for climato-economic theory?

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Abstract: Does the interaction between climatic demands, monetary resources, and freedom suggest a more general relationship between the environmental challenges that human societies face and their resources to meet those challenges? Using data on press freedom (Van de Vliert 2011a), we found no evidence of a similar interaction with natural resources (as measured by oil exports) or risk for natural disasters.

Van de Vliert’s target article offers a climato-economic explanation for variation in fundamental freedoms across countries. The crux of the theory is an interaction between climatic demands (CD) and monetary resources (MR), which on average accounted for 10% of the variance in different measures of freedom. Because the data are correlational, there is a possibility of other variables being confounded with the interaction or being causally linked to freedom. An important question for the theory is whether the CD * MR interaction is a manifestation of a larger dynamic between the resources that a human society possesses to meet challenges imposed by the environment, or is limited specifically to climatic demands and monetary resources. Here we consider the possibility of a larger dynamic by testing if easily exploitable natural resources and risk for natural disasters explain additional variance in freedom or show similar interactions as reported in the target article.

When a society discovers a valuable resource, such as oil or natural gas deposits, the discovery often proves a mixed blessing and may even be a curse (Ross 1999). For example, Sachs and Warner (2001) showed that countries with greater natural resource wealth tend to have slower economic growth. Gaidar (2007) claims that an important factor in the collapse of the Soviet Union was the volatility in export income produced by an excessive reliance on oil exports. Ross (2006) points to a high incidence of civil war in resource-rich countries that may, in turn, result from a number of different causes. Hence, there is good reason to believe that freedom is not enhanced by a bonanza of natural resources.

We obtained a measure of Oil Exports (as the natural logarithm of oil export figures from the World Factbook (Central Intelligence Agency, 2010, Country Comparisons, Crude Oil–Exports), and setting log(0) equal to 0), for the 85 countries in Electronic Supplement 1. Using the measure of press freedom from Van de Vliert (2011a), regressions confirmed the main result reported in the target article: Effects of MR and the CD

* MR interaction were significant ($R^2_{\text{Total}} = .56$). However, Oil Exports contributed significant additional variance ($\Delta R^2 = .10$), such that, as anticipated, countries with higher oil exports had lower levels of press freedom. Oil Exports did not correlate significantly with either MR or the interaction, and their beta-weights in the regression were virtually unchanged. (Sachs & Warner, 2001, also report that resource curse is not explained by geographical variables.) When Oil Exports were substituted for MR, the main effects of CD and Oil Exports were significant ($\beta_{\text{CD}} = .30$; $\beta_{\text{Oil}} = -.25$; $R^2_{\text{Total}} = .16$), but the interaction was not ($\Delta R^2 = .01$). These results suggest that natural resources are not equivalent to monetary ones in terms of an interaction with CD on freedom, but that the “resource curse” represents a negative influence on freedom that explains about the same variance as the CD * MR interaction.

Resource curse resembles climatic demands in being an intuitively plausible explanation of at least moderate authoritarianism: a country that has abundant resources does not need to be efficiently or democratically organized; a society with an easy climate may be less concerned about political and press freedom. It is also easy to think of countries with abundant resources that have less freedom: The Middle East provides obvious examples. Yet, as Haber and Menaldo (2011) point out, one can also find counterexamples: Ecuador, Botswana, and Mexico have used their resources to democratize.

Natural disasters pose a significant challenge to the maintenance and sustainability of human society. Based on Van de Vliert’s theory, one might expect that an increased risk for natural disasters would function similarly to climatic demands in terms of diverting resources from other needs, and that a similar interaction between risk for natural disasters and monetary resources on societal freedom would be observed. As a measure of natural disaster risk we used the Exposure index, a component of the United Nations WorldRiskIndex (United Nations University 2011), which measures the likelihood of natural hazards including earthquakes, storms, floods, droughts, and sea level rise. When the Exposure index (log transformed) was substituted for CD in regression analyses with the 85 countries, neither its main effect nor the interaction with MR was significant ($ps > 0.26$; $\Delta R^2 = .01$), while MR continued to explain significant variance ($R^2 = .47$). The Exposure index also did not explain additional variance beyond the model with CD, MR, and CD * MR ($\Delta R^2 = .01$).

The puzzle is why environmental challenges associated with climatic demands but not risk of natural disasters would influence societal freedom, moderated by monetary resources. Although natural disasters are relatively infrequent events (even for high-risk areas), in contrast with climatic challenges that recur year after year, adequate preparations for natural disasters must also be ongoing (e.g., earthquake building codes). From the perspective of Van de Vliert’s theory, there appears to be no fundamental difference between climatic demands and natural hazards risk in that both require a diversion of resources, and so both should trigger the same psychological mechanisms described in the target article.

The climato-economic theory offers an intriguing new perspective on the complex factors that may shape the evolution of human societies to freedom or authoritarianism. Our results pose the following question for Van de Vliert: Why would the interaction be specific to climatic demands and monetary resources, and not other types of environmental challenges or natural resources? Of course, although a country may find new natural resources, it is not likely to discover a new climate. Van de Vliert does, commendably, indicate likely future changes in climate and the effect these are likely to have. However, it seems to us that an historical analysis could also be made. As climate has not changed markedly in the last hundred years or so, it should be possible to find rather similar patterns of the reliance on the monetary resources and climate demand interaction when one looks at past societies. Indeed, overall the model suggests that the pattern of freedom should be enduring except for the effect of monetary resource changes.

Individual identity and freedom of choice in the context of environmental and economic conditions

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Abstract: Van de Vliert's findings fit nicely with our recent arguments implying that (1) differentiated selfhood is partly motivated by requirements of cultural groups, and (2) free will mainly exists within culture. Some cultural groups promote individual freedom, whereas others constrict it so as to maintain elites' power and privilege. Thus, freedom is, to a great extent, a creation of culture.

All over the world, human beings live in cultural groups, that is, in groups that share information, work together with differentiated, complementary roles, engage in some form of trade or exchange, and pass on their social structures and knowledge to subsequent generations. Some groups allow their members considerable freedom, whereas others severely constrain individual freedom. In the target article, Van de Vliert has identified one significant pattern, which is that freedom depends on a combination of climate and economic success—such that freedom is highest in relatively rich places with harsh climates.

We connect Van de Vliert's findings to the emergence of the individualistic form of selfhood that promotes inner exploration of the single person and allows people to choose and define who they are. This may be a historically and culturally relative form of selfhood. It emerged first in Europe around the time of the Renaissance (thus rich societies with some harsh climates) but gradually is now spreading to other parts of the globe (see Baumeister 1986; 1987 for overview). It replaces a previously more universal form of selfhood in which identity was largely assigned to individuals by fixed circumstances of social position, exploration of inner selfhood was minimal or trivial, fulfillment was defined by society (usually in religious framework), and self-definition was a moral matter of performing one's assigned roles.

Participation in culture raises fundamental choices between group collective control (what Van de Vliert calls "ingroup agency") and individual freedom. Van de Vliert proposes that the resulting latitude of individual freedom depends on interaction between material wealth and climate stresses. Harsher climates are threatening to materially poor cultures, and threats cause these groups to curtail freedom so as to enforce conformity. In contrast, harsh climates are challenging (as opposed to threatening) to rich cultures, and so they let individuals cope and adapt as they wish. In part, the harsh climate motivates people to improve their comfort by working hard and pursuing individual goals, in effect enabling the individual to obtain a large share of the available wealth by dint of individual effort and thereby to improve life for his or her family substantially. When the climate is benign and pleasant, everyone lives reasonably well with minimal effort, so there is not much motivation for individuals to work hard and try new things.

Human selfhood is vastly more complex than what is seen in other species. This is not limited to the overgrown, complex, individualistic modern self but is true even of the simplest selves in simple, early societies. One partial explanation for special nature of human selfhood is that cultural groups benefit from differentiation of selves. Baumeister et al. (2012, submitted) reviewed the research literature on group functioning in light of the

seeming contradiction that many studies have found groups to be more than the sum of their parts—whereas many other studies have found them to be considerably less. The difference depended heavily on the degree of differentiation versus submerging of the self in the group. The pathologies of groups (e.g., social loafing, groupthink, diffusion of responsibility, mob violence) mainly arise when selves are submerged in the group and individuals conform to others. In contrast, the best results of group action (e.g., social facilitation of individual performance, wisdom of crowds, improvements in efficiency and productivity through division of labor) are achieved by differentiating individual selves. The latter includes encouraging independent thought and judgment, making people feel their unique contributions are indispensable to group success, and holding people morally accountable for their actions.

The highly internal, individualistic form of selfhood that emerged in Western Europe after the Renaissance took greater advantage of differentiation of selfhood than previous societies. Although the earlier ones certainly differentiated roles, the operation of individual agency in performance and information-gathering was greatly enhanced in early modern Europe. The freedom of individuals to pursue their own competing goals, in flexible partnerships rather than rigidly defined positions in immobile social hierarchies, almost certainly contributed to making those societies rich by promoting trade and innovation. Whereas Van de Vliert emphasizes that wealth (under harsh climate) promotes freedom, we think that freedom increases wealth also. In any case, the bottom line is that greater freedom (to act as an autonomous agent within the system) is an important part of the historically new, more advanced form of human selfhood.

Elsewhere one of us has argued that free will mainly exists within the context of culture (Baumeister, in press). The possibility of exerting freedom, including rational choice based on meaningful understanding and the exertion of self-control to adapt one's behavior to standards, is greatly increased by living in culture with language and rules. Van de Vliert's work contributes to this view and thus to the free will debate by suggesting that the very motivation to exert free, autonomous choice varies according to cultural context, including climate demands and economic prosperity that reward autonomous effort. Rich cultures offer greater freedom of choice and greater opportunity for self-definition than poor cultures, and harsh climates may motivate people to exert themselves to find ways of making life better. Freedom is hence to a substantial degree a creation of culture.

Again, though, some cultures promote freedom, whereas others restrain it. In poor cultures in harsh climates, elites may use the idea of free will simply to hold people responsible for doing what they are expected to do. Actual freedom is thus restrained, because free action by the majority would jeopardize the privileges of the elite. In contrast, rich cultures with harsh climates can permit greater freedom, and free will becomes a matter of the individual acting as an autonomous economic, political, and social agent.

Play, animals, resources: The need for a rich (and challenging) comparative environment

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Abstract: Van de Vliert proposes a comprehensive explanation for differences in "freedoms" in diverse human populations based on climate and monetary resources. This intriguing approach, though derived from an

evolutionary view covering all species, is based exclusively on human populations. This anthropocentric lens is challenged by ways of testing Van de Vliert's thesis more generally using playfulness as a surrogate for freedom.

Van de Vliert is courageously taking up the challenge to understand differences among nations in terms of culture, wealth, and climate. It is also timely as the consequences of climate change are receiving much interest from conservationists, agronomists, economists, military planners, and others. Not in a position to critically evaluate the data and analyses in the current paper, I accept them as useful summaries given current knowledge. However, there are ways of enriching the analyses and testing the hypotheses by going beyond the exclusive human-focused anthropocentric lens by considering other species and the rich comparative data being gathered on them. Here I can only touch on a few possible approaches that might be explored in the future. These include inter- and intraspecific variation in non-human animals (especially primates) in social organization, resource availability, and play.

Van de Vliert begins by positing the evolutionary link between the behavior (habits) of all species and their ecologies (habitats), but then proceeds to use often heavily massaged data to classify human populations as residing in areas with extreme *versus* benign environments and being either wealthy or poor. Nonhuman populations also live in areas and confront great variation in climatic challenges and resource availability. Any explicitly evolutionary approach should not begin with humans as being unique and thus countenance disregarding other animals. Perhaps they are, but assuming this uncritically has blindsided scientific progress in the past, whether the topic is tool use, language, cognitive theory, aggression, altruism, empathy, or creativity. Indeed, the very last sentence in the "coda" (sect. 6.4) repeats this speciesism. Money is, ostensibly, the main element in the present analysis that could distinguish us from other species. But this is disingenuous. First, Van de Vliert does allow that nonmonetary resources can be involved in human societies, and is obvious from the role of trading in ancient and even some current small-scale societies. Second, animals have been trained in token economies and other settings where objects can become generalized secondary reinforcers, which is how Skinner and other learning psychologists characterized money.

Regardless, the critical claim that Van de Vliert makes concerns those living in extreme (challenging) environments. In such climatic settings, those with poor resources have social and political systems with more social rigidity and conformism and less opportunity for individuals to have "freedom," as measured in terms of survival needs, political freedoms, and reaching one's potential through self-expression and individual opportunity. But other species also vary in their social organization. The role of ecology (habitat structure, food, water, temperature, predators, disease) in social organization, for example, is quite robust, and work on this topic goes back decades (e.g., Crook 1970).

Nonhuman primates are obvious taxa to study as they have great variation in social systems, including, for present purposes, rigid hierarchical dominance systems to others based on "fission-fusion," family groups, and so forth. Primates, even in the same or related species, can occupy habitats varying from "benign" to those that are cold, dry, or food-limited. For example, although all macaque monkeys share a basic social dominance system, it varies greatly among the species in this genus (Thierry et al. 2000). Do populations of macaques in more stressful environments (e.g., climate, food, predator risk) have more stereotyped and individually constrained behavior than those in environments where food and other stresses are rare? We do, know, for example that in macaques, the Japanese ("snow monkey") macaque, perhaps the least "tropical" large monkey (it even has lost most of its tail), has a far more rigid hierarchical social system than the Tonkean macaques, who live in a rather benign habitat. This suggests that ecological, as well as phylogenetic, factors have historically played important roles in social behavior.

What about freedom and tolerance for individual expression? In animals, play is clearly one way in which they express themselves in seemingly nonsurvival behavior where the social rules are bent and where individuality and creativity (as in locomotor and object play) are tolerated. Thus, play can be a surrogate measure of freedom and plugged into Van de Vliert's analysis. Pellis and Iwaniuk (2000) concluded from a phylogenetic analysis of all groups of primates that adult play is limited or absent in species with rigid social hierarchies. In human societies, the lack of tolerance for artistic freedom (creative play) in Fascist, Communist, theocratic, and other authoritarian regimes is well known (Burghardt 2005). Here societal wealth is not so much the issue, perhaps, as how it is distributed and controlled, as well as the context in which such regimes emerged. Interestingly, a recent comparison in juvenile play in the two macaques mentioned above documents that Tonkean macaque juveniles play in longer and more variable bouts, and with less competition and more cooperation, than do Japanese macaques (Reinhart et al. 2010).

Not only is play inversely related to rigid social organization, it is also related to the availability of resources. For example, squirrel monkeys in food resource challenged environments play far less than the same species in habitats with ample food (Baldwin & Baldwin 1974). This finding has been replicated in many species and also supported through experimental manipulations (see Burghardt 2005, pp. 157–61). Findings such as these led to the development of the surplus resource theory of play (Burghardt 1988; 2005) in which play in animals is more likely to evolve in species with the physiological and behavioral attributes to expend surplus resources of energy and time in behavior that can enhance learning, flexibility, adaptability, novelty, and innovation.

Van de Vliert ends by making some predictions about changes in freedom as a result of climate change. One can see parallel shifts in animal populations. For example, California sea lion play was reduced following El Niño events that reduced food availability (Ono et al. 1987); such findings open many avenues of future research. In short, grounding the hypotheses developed by Van de Vliert in more rich comparative perspective may allow testing them with more rigorous and biological approaches than seems currently congenial to some segments of evolutionary psychology (Burghardt 2013).

Cultural adaptation to environmental change versus stability

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Abstract: The target article provides an intermediate account of culture and freedom that is conceived to be curvilinear by treating economic development not as an adaptive outcome in response to climate but as a cause of culture parallel to climate. We argue that the extent of environmental variability, including climatic variability, affects cultural adaptation.

Van de Vliert proposed and tested the interaction between climate and economics in effecting population variations in freedom

seeking. Although the theory has shown explanatory power based on several datasets, we believe it remains an intermediate but not ultimate explanation of culture and freedom. Within Van de Vliert's framework, we discuss three issues to provide an ultimate explanation of cultural adaptation.

First, an intermediate explanation derives from Van de Vliert's definition of climatic demand. Defining a temperate climate of 22°C as the least demanding on or most fitting to human existence and defining both cold and hot deviations from it as equally demanding reflect such contemporary human living conditions as clothing and walled shelters, which already are cultural adaptive outcomes. Climate as an ultimate cause of cultural adaptation ought to reflect ancestral living conditions in Africa without man-made cultural artifacts. The fact that humans originated from Africa suggests that the hotter and less variable African climate is less demanding on human existence than a temperate climate to which humans culturally adapted by wearing clothes and building thermally more insulated shelters after they migrated out of Africa. Because of the African origin, a colder climate should have been more, rather than equally, demanding on human beings than a hotter climate and should have exerted stronger pressure for cultural adaptation. Thus, Van de Vliert's bi-directional definition of climatic demand is inaccurate in a long evolutionary view on cultural adaptation. Separately, as a covariate of climate, the effect of pathogen on cultural adaptation also aligns with the one-direction but not bi-direction model of climate demandingness in that, for example, as climates change to be hotter but not colder or in both directions, familism and religiosity (Fincher & Thornhill 2012) and conformity and social learning increased (Chang et al. 2011; Wu & Chang 2012).

Second, economic condition is another intermediate variable, but it is not an ultimate cause in an evolutionary explanation of culture and freedom. In fact, the man-made economic condition is itself a cultural adaptive outcome in response to climate. A more ultimate variable is natural resources represented by flora and fauna to sustain the food chains necessary for human existence. The abundance of these basic resources is linearly and positively correlated with climate, with hotter and less variable climates but not temperate climates of 22°C providing rich flora and fauna. Economics being a cultural adaptive outcome in response to climate, but not an ultimate cause of culture parallel to climate, is also shown by the wide observation that populations of colder and more variable climates with fewer natural food resources created more wealth than populations in hotter and less variable climates with more natural food resources (Masters & McMillan 2001; Nordhaus 2006; Strulik 2008). When treating man-made economic development as a cause, rather than an outcome, in analyzing cultural adaptive processes, the reported climato-economic interaction effect may be misleading. Climate may not have been moderated by economic development as Van de Vliert claims. Instead, real thermal temperature may be counted into the analysis only in poor regions of the world but not in rich regions where economic development represented by such climate neutralizers as air conditioning makes the demanding or variable thermal conditions into a constant. Combining such "man-made" with natural climate into the same analysis results in the putative climato-economic interaction whereby climate is thought to relate to freedom differently depending on economic development.

Third, a longer distal view suggests that climate change versus stability over time evoked cultural adaptation more than thermal temperature, whereas the present theory based on thermal levels but not climate variations limits an ultimate account of culture. Much evidence shows that climatic variations drive cultural adaptation (Mercuri et al. 2011), as well as brain development among human beings (Ash & Gallup 2007; Potts 1998) and other mammals (Jerison 1973). The fact that human cultural evolution started or accelerated (Klein 2002) after but not before humans left Africa supports this argument because

both seasonal climate variations such as variation in daytime length and solar radiation energy received within a year (Loutre et al. 2004) and temporal climatic variations such as variations in rainfalls or drought and flood across centuries (Cashdan 2001; Stevens 1989) increase as the distance away from the equator increases. Because climatic variation is linearly correlated with climatic temperature in that climate gets colder and more variable with increasing distance from the equator, the cross-cultural differences data reported either in the present study or in the literature may well have registered the effect from both climate variation and thermal temperature and from the former more than the latter.

We propose an environmental variability model by which cultures result from different extent of environmental variability over time, including climatic variability. Cultures including freedom from want and fear and freedom of expression and participation are defined as specific ways to adapt to the local environment consisting of survival difficulties and demands or challenges and opportunities, to use Van de Vliert's terminology. These cultural adaptive methods are mediated by social learning, or copying existing solutions, and individual learning, or innovating by trial and error (Boyd & Richerson 2005), two fundamental problem-solving methods in response to environmental change versus stability (Chang et al. 2011). A relatively more changing environment, including variable climate, evokes cultural adaptive strategies that rely more on individual learning to solve new problems, whereas cultural adaptive strategies depend more on social learning in response to a relatively unchanging environment where existing solutions are adequate in solving old problems. Individual learning or solving new problems on one's own activates and, in turn, is facilitated by a set of values and beliefs known today as Western democracy and freedom. These include what Van de Vliert describes as individualism and self-actualization, independence and equality, and freedom of expression and participation, all of which are fundamentally related to individual learning or being able to work on one's own. By non-randomly copying successful solutions made by other conspecifics, social learning fundamentally concerns working with others and promotes collectivistic values based on social hierarchy and ingroup discrimination rather than equality. The overall lack of individualism and social equality, characteristic of low levels of freedom, facilitate copying selectively solutions of the majority or of the successful individuals characterizing social learning (Boyd & Richerson 2005). Climate as an ultimate cause of culture contributes to environmental stability versus change that evokes reliance on social versus individual learning in adapting to the relatively unchanging versus changing environmental characteristics. Western democracy and freedom and other value systems have evolved resulting from and facilitating individual and social learning.

Frontier migration fosters ethos of independence: Deconstructing the climato-economic theory of human culture

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Abstract: Evidence Van de Vliert draws on is more consistent with the idea that settlement in the frontier encourages independent mentality and individualistic social institutions. This cultural system can sometimes flourish, generating both wealth and power, but clearly not always. In our view, wealth is, for the most part, a measure of success of any given

cultural group, and climate is important to the extent that it plays a role in creating rugged lands of frontier.

The article by Van de Vliert is timely, addressing an important issue. However, the data Van de Vliert reports are ambiguous. In fact, they are more consistent with an alternative perspective that highlights the potential significance of frontier migration as a force that produces an ethos of independence.

Regarding his international analysis, it is apparent from Figure 2 in the target article that what Van de Vliert calls “demanding” climate appears mostly the result of severe winter rather than extremity in climate in general. More important, however, countries located in the upper right quadrant are almost always Western or Northern European (e.g., United Kingdom and Finland) or the countries derived from them (United States, Canada), whereas countries located in the lower right quadrant are in large part ex-Communist (e.g., Russia, Kazakhstan).

Countries in the northern hemisphere underwent massive historical changes over the last several hundred years, culminating in capitalist economy in Western Europe and communism in Eastern Europe. Eventually the capitalist system flourished, whereas the communist system eventually collapsed. Although the climato-economic theory suggests that the different paths were the result of the economic resources each system had at the very beginning, given the fact that Western Europe was a rather poor and backward region during medieval times (Kennedy 1989), it is sensible to hypothesize that wealth is, for the most part, a product of any given sociocultural system.

We may suggest that cultures that prospered nearer to the equator expanded, over historical time, to colder regions with the advancements of living conditions (Diamond 1997). These colder regions were initially frontiers. Because people had no stable community to rely on, their frontier migration and eventual settlement are likely to have bred an independent mentality (Kitayama et al. 2006; 2010). Indeed, independent values including self-promotion and initiative, innovativeness and creativity, are likely to have been indispensable for survival. Independent ideas and practices, in turn, may prove highly successful in generating wealth (not vice versa) under certain conditions as in Western Europe. It may further be speculated that in regions where individualism was best suited for survival, following less individualistic practices (i.e., communism) was not suitable for wealth production and the system ultimately failed.

Van de Vliert’s regional analysis also meets with some challenges. Chinese regions that Van de Vliert identifies as relatively lower in collectivism are in the temperate south, whereas the regions he identifies as higher in collectivism are in the colder north, as well as in the western territories. The southern regions are conducive to rice farming, having rich, fertile land and abundant rain (Talhelm et al. 2012). Because rice farming requires substantial social coordination, one may expect the southern regions to be more collectivistic (Uskul et al. 2008). In contrast, the northern, as well as far-western, regions of China are not suitable for rice farming. Much of the western region is desert and high-elevation plateaus, where herding is a more dominant mode of living. Even when farming is tried, the main crop is not rice but wheat, which requires much less social coordination (Talhelm et al. 2012). Given these reasons, one would expect regions in the northwest to be more individualistic, contradicting Van de Vliert’s main claim. In fact, when we analyzed province-wise divorce rates (a face-valid indicator of individualism, taken from Talhelm et al. 2012) as a function of Van de Vliert’s climatic demand index, we observed a strong positive correlation, $r = .70$, $p = .005$. Harsher climates were strongly related to individualism. We suggest the frontier-like regions of the northwest may have fostered individualism.

In his analysis of China, Van de Vliert relies exclusively on a self-report measure of collectivism. While such rating scales are

excellent to assess individual differences within a group, they should be complemented by other measures when applied to between-group comparisons as there are some complex issues (Kitayama 2002). For example, different groups might have very different interpretations of each item. Does “attending a weekly community meeting” make one a loyal member of the community? It depends. The southern, more collectivist regions might have more stringent criteria in defining what counts as “loyal.” If so, a southerner might judge himself as less collectivist on this item than a northerner might.

Now regarding the regional variation within the United States (Fig. 3 of the target article), one major problem is that Van de Vliert neglects settlement history of the United States, which likely had major impacts on the contemporary mentality of Americans (Kitayama et al. 2010). To test whether settlement predicts collectivism, we analyzed cold climate demand (heat demand was not a significant predictor, thus excluded) and frontier settlement in relation to collectivism across the United States. We controlled for Hispanic and Asian births, as these groups can inflate collectivism scores (based on Vandello & Cohen 1999), and excluded Hawaii because of its unique island nature. We found that young state age, a proxy for settlement, is a significant predictor of less collectivism ($\beta = .32$, $p = .044$). In addition, cold (but not hot) climate had a significantly negative (or positive) effect on collectivism (or individualism), $\beta = -.44$ ($p = .004$), consistent with the notion that migration to colder regions fosters an independent ethos.

To conclude, one common thread running across the three cases discussed in this commentary is the significance of migration to “frontiers” or rugged lands of cold winter and sparse population. We suggest that once properly analyzed and understood, the data are more consistent with the idea that settlement in the frontier encourages independent mentality and individualistic social institutions (Kitayama et al. 2010). This cultural system can sometimes flourish, generating both wealth and power (Kennedy 1989), but clearly not always. In our view, wealth is, for the most part, a measure of success of any given cultural group. Climate is important to the extent that it plays a role in creating rugged lands of frontier. Thus, it is not climatic demand in general, but cold winter that matters the most. Future work should examine under what circumstances individualistic ideas and social practices might “succeed,” producing both wealth and power for a given nation.

Is there a role for “climatotherapy” in the sustainable development of mental health?

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Abstract: Climate, diet, lifestyle, and environmental settings have all been shown to modulate mood, play a role in mental disorders, and even pose a mental health risk. Can climatotherapy, in its adaptive approach aiming to restore balance among the economic, social, and ecological realms of human societies, situate itself as a therapeutic avenue for the promotion of sustainable mental health?

Van de Vliert is to be commended for revealing and explicating the importance of climato-economic habitats on patterns of human stress. This commentary presents further arguments to suggest that climate, diet, lifestyle, and environmental settings are also able to modulate mental health. Our alternative explanation builds on prior clinical practice of climatotherapy and recent researches demonstrating that climatotherapy might be a therapeutic avenue for the sustainable development of mental health.

When taking care of a goldfish, we take into consideration water quality and oxygenation, temperature and luminosity of the aquarium, diet, and so forth. When it comes to taking care of ourselves, the impact of these environmental factors on our behaviours and mental health is often less evident.

Long before the development of theories linking the economy to climate, however, theories have involved climate as a factor in the regulation of emotions. Under the term climato-therapy, the influence of climate was described as a causal factor in mental disorders. Its action could be direct, either brutal (acute delirium linked to sun stroke) or insidious (depressive state of a more or less long duration). Its action could also be indirect, either through specific infectious diseases in countries and climates (malarial psychosis, dysenterial psychosis, etc.), or through toxic habits (opium addiction, colonial alcoholism, etc.), or finally through moral and social conditions in which they are found (nostalgia, disorientation, etc.). Admittedly, Van de Vliert discusses patterns of prevalence of mental health problems according to threat, comfort, or challenge appraisals as a competing explanation. However, for Van de Vliert climate is perceived as an element of fate and not a therapeutic tool applicable in mental health.

Surprisingly, the concept of climatotherapy, formerly used in mental health, has been taken up again primarily with regards to dermatologic disorders, such as psoriasis, atopic dermatitis (Adler-Cohen et al. 2012) or vitiligo (Czarnowicki et al. 2011). Depending on the disorder, the described effects can either be acute or chronic (Schuh & Nowak 2011).

Several hypotheses could review the first intuitions of mental treatments. First is the hypothesis that there is a link between depression and vitamin D (of which a deficiency is more important in less sunny climates), which rests on the observation that vitamin D improves depression and other mental disorders (Penckofer et al. 2010), that it increases following climatotherapy, and that it reduces musculoskeletal pain, such as that encountered in fibromyalgia (Harari et al. 2011). A second hypothesis is that mental disorders are linked to diet (Desseilles et al. 2013), for example, the concentration of lithium in the groundwater influencing the prevalence of mood disorders (Schrauzer & Shrestha 1990). Third is the hypothesis linking lifestyle to mental disorders, such as the notion of the urban environment posing a mental health risk. Indeed, anxiety and mood disorders, as well as schizophrenia, are more prevalent among city dwellers (Krabbendam & van Os 2005; Mortensen et al. 1999; Pedersen & Mortensen 2001; Peen et al. 2010; van Os et al. 2004). Living in a city has also been associated with increased activity of the amygdala, known for its role in emotion regulation (Lederbogen et al. 2011; Mikolajczak & Desseilles 2012).

We could also easily imagine that architecture (e.g., Roesler 2012) and the living environment have a psychological impact on individuals and that climate, topography, or both could influence mental health through their previous impact on what and how individuals have built and planned their surroundings. These ideas have led to the notion of environmental psychology (De Young 1999) and to that of sustainable development, which has been popularised by the report from the World Commission on Environment and Development, created in 1983 by the United Nations. The report aims to reconcile the economic, social, and ecological

dimensions of human societies. Indeed, historical sites, representations, and objects that have a cultural, scientific, symbolic, spiritual, or religious value are important manifestations of the culture, identity, and religious beliefs of a society, and they are also important factors to stability and humanity within society (United Nations 1997). Therefore, historical sites and monuments could be used as remedies to psychological imbalance caused by the rapid urbanisation of society (Council of Europe Parliamentary Assembly 1970).

Furthermore, convalescence and treatment settings – prized for their environmental or natural qualities (natural sources, thermal cures, sunbathing,...) and their services (lodging, dietary, distractions), – combined to cures of hydrotherapy, act through mental and physical rest, through the interruption of activities and professional preoccupations, and through disorientation or a change of scenery. These hydro-climatic cures were one of the first physical treatments of mental disorders.

Of course, we can isolate a lot of climatic factors, which are actually studied scientifically in dedicated protocols enabling us to shed light on their physiopathological and psychopathological implications. Let us therefore note the studies linking ambient temperature to the physiopathology of depression (Rosenthal & Vogel 1994), or dehydration to mood (Armstrong et al. 2012), or light to mood (Golden et al. 2005), as well as high altitude and hypoxic condition to mood and cognition (de Aquino Lemos et al. 2012). Among bipolar patients, meteorological factors such as temperature could influence the onset of new episodes (Christensen et al. 2008).

Last but not least, Van de Vliert's climato-economic theory also points to the effect of global warming, but without contemplating its opportunities, consequences, or risks on mental health. Indeed, climate and its catastrophic variations can also lead to numerous psychological damages, particularly among vulnerable persons (Neria & Shultz 2012). The challenge in mental health comes from the fact that interventions bear on unforeseeable elements – their occurrence, extent, and consequences. These dramatic consequences to climates could become more frequent and virulent as a result of global climate change (Aldy & Stavins 2012). In this way, early identification of exposed persons and a rapid and efficient intervention for individuals at risk of developing mental health disorders seem vital, alongside the consideration of climatic refugees or eco-refugees (Myers 1994). Climate modifications can therefore be an occasion to promote mental health (Berry 2009) adapted to specific environments, populations, and available budgets.

Improving climato-economic theorizing at the individual level

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Abstract: Using representative data from 55 nations, I show that individual level wealth interacts with climate in predicting individual happiness but not postmaterialism values. I propose that more research is needed to identify (a) the specific mechanisms of how wealth buffers climatic demands at the individual level and (b) the neurocognitive and physiological reactions of individuals situated in different ecological niches.

Van de Vliert argues that demands placed on humans, if not met by sufficient resources to cope with these demands, will lead to malfunctioning and stress of the individual. Impressive evidence is

provided at the population level. Van de Vliert's model appeals to demand–resource processes at the individual level. Despite individual-level theorizing, Van de Vliert has not evaluated individual level effects. Do climatic demands and wealth influence individuals directly? I used multi-level modelling and representative World Values Survey (WVS) (2005) data from 80,952 individuals in 55 countries, with climatic demands and log-transformed wealth in 2005 as population level predictors. Dependent variables were self-reported happiness (V10, How happy are you, on a scale from 1 “Very happy” to 4 “Not at all happy”) and postmaterialism values (emphasising quality of life, protection of the environment and lifestyle issues, ranging from 0 “Materialist” to 5 “Postmaterialist”). I controlled for age, education (both group-mean centred), and gender (1 “male”) at the individual level. The interaction effect was significant for both happiness ($\gamma = -0.066$, $SE = 0.025$, $p < 0.05$) and postmaterialism ($\gamma = 0.158$, $SE = 0.044$, $p < 0.01$) and in the predicted direction: Happiness and postmaterialism scores of individuals increased when they were living in a richer country with more demanding climate. This shows that the macro-level effects influence individuals in representative samples (see Van de Vliert et al. 2013b for regional evidence).

Van de Vliert to date has not demonstrated or discussed whether monetary resources at the individual level operate as buffers of climate effects when predicting individual level responses. I used country-specific scales of incomes (V253; measured on a 10 step ladder, 1 “Lowest decile in country” to 10 “Highest decile in country”) from the WVS. The cross-level interaction between climate at country level and individual-level income on happiness was significant: $\gamma = -.008$, robust $SE = .003$, $p < .05$, even after controlling for the country-wealth by climate interaction ($\gamma = -.076$, $SE = .029$, $p < .05$) on happiness first. Greater income was associated with more happiness, and this association was strongest in demanding climates. In other words, income has a stronger association with happiness if there are climatic challenges. The effect was independent of the interaction between country-level wealth and climate. No interaction effect with income for postmaterialism was found: $\gamma = -.005$, $SE = .005$, $p = .36$, requiring more research to identify individual level resources that counter climatic demands on values. This shows that individual-level wealth may act as a buffer of climate effects on well-being related variables, but independently of the macro-level effects.

I suggest two avenues for further refinement. First, we need to pay greater attention to the specific buffering mechanisms of wealth in specific ecological niches. Do wealth effects increase the capabilities and agency of individuals (leading to mutually reinforcing collective empowerment effects, independent of effects on individuals)? Such contextual enhancement effects have been used to explain path dependencies in models of societal value change and political participation (Welzel 2012). Is it possible to identify wealth effects in specific domains that mediate the overall buffering mechanism of national wealth? Such domain-specific wealth effects may depend on the criterion variable of interest. For example, freedom from want may depend more on monetary investment in health and child care (increasing access to care and improving health of individuals), whereas freedom of expression may depend more on educational resources available to individuals (access to education, libraries, Internet, and other educational resources). Furthermore, I found an effect of income of individuals expressed as income deciles within the national income distribution. This raises the question whether relative income or absolute income are psychologically more important: Do we need to focus on the absolute levels that are necessary to counter specific climatic threats or does the relative position within the income hierarchy exert additional benefits (over and above satisfying basic needs)?

Second, it is worth exploring biological (including physiological and neurocognitive) functioning of individuals who are living in different ecological and economic niches to identify implicit psychological processes that underlie and contribute to the emergence of these macro-level effects. At a basic level, demands

placed on the organism and the subjectively available resources for the organism to respond to these need to be examined more carefully. The amygdala is actively involved in emotional appraisal of potentially threatening information (Adolphs 2009); however, a constant activation in more stressful environments is maladaptive for the organism. Other brain areas such as the prefrontal cortex are important in the down regulation of “fear” representations (Thayer et al. 2012). This activation and regulation of the amygdala-prefrontal cortex complex is conceptually linked to the types of appraisals identified by Van de Vliert.

An effective interplay of various brain regions in the appraisal and regulation of stress-related information is essential for optimal human functioning. One promising marker of an effective regulatory system that is relatively understudied is heart rate variability (Thayer et al. 2012). Other options include more experimental examinations of stress responses (e.g., startle reflex). One promising avenue for research is to examine how environmental demands impact on these basic physiological and neurocognitive mechanisms as they are important for the appraisal and regulation of stressors and resources. The effects demonstrated by Van de Vliert at the population level may be based in basic neurocognitive and physiological responses of the organism in specific environments, without directly being related to conscious responses to the environment. Implicit psychological mechanisms are not necessarily linked to explicit conscious awareness, but nevertheless can have significant effects on behaviours (Gawronski et al. 2006).

The two avenues discussed can be studied in combination. Specific wealth-based mediators such as access to education or availability of effective care may influence the physiological reactivity of the organism and co-determine behavioural reactions to ecological demands. The reported effects at the population level are persuasive and have contributed to a much better understanding of the origins of cultural and social differences. The next challenge ahead is to improve the precision of the theory at the individual level to understand how the demand–resource interactions play out in the brains and bodies of individuals.

Ecological priming: Convergent evidence for the link between ecology and psychological processes

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Abstract: This commentary describes the use of ecological priming methods to address the limitations of the correlational research discussed in the target article. We provide examples from our own work on cultural tightness–looseness to illustrate how we can bring ecological and societal conditions into the laboratory in order to study the impact of ecological threats on psychological processes experimentally.

Van de Vliert's tour de force illustrates an important interaction between ecology and societal resources that replicates across numerous studies. The extent to which nations are able to use monetary resources to meet climatic demands leads to fundamentally different psychological and behavioral adaptations. The research is consistent with our work on cultural tightness–looseness, which shows that other aspects of the ecology that threaten human survival (e.g., resource scarcity, natural disasters, disease, territorial threats) can be met with other societal resources, namely, the strength of social norms and punishments (Gelfand et al. 2011), which affects a wide range of cultural differences.

Nonetheless, both our fieldwork and Van de Vliert's are limited, as he aptly notes, given the inherent correlational nature of cross-cultural fieldwork. Can we use other research methods that go beyond correlational studies to ascertain whether ecology causes differences in freedom of self-expression, ingroup favoritism, and outgroup derogation? Testing a theory with multiple methodologies affords more confidence in results, particularly in cross-cultural research that presents many rival hypotheses (Gelfand et al. 2002). To that end, we (Lun et al. 2012) implemented an ecological priming paradigm to examine whether one can prime ecological and historical threats that occur naturally in the real world in controlled laboratory settings. By making societal threats temporarily accessible, we can observe the impact of ecology on psychological processes and examine whether the effects are similar to those found in large-scale correlational studies. Although scholars have long argued that cultural differences can be primed using classic social cognition methods (Oyserman & Lee 2008; Trafimow et al. 1991), the application of priming methods to study ecological influences on behavior is surprisingly limited (see Mortensen et al. 2010).

In our field research, we showed that cultures vary considerably in the degree to which they are *tight* – that is, have strong norms and a low tolerance for deviant behavior – versus *loose* – that is, have weak norms and a high tolerance for deviant behavior (Gelfand et al. 2011). Tightness-looseness is related to a broad array of ecological and human-made threats that nations have (or have not) historically encountered. As compared to loose cultures, tight cultures have greater resource scarcity, more vulnerability to natural disasters, higher disease prevalence, higher population density, and a greater degree of threats from neighboring countries. Psychologically speaking, people in tight cultures have more of a prevention focus (Higgins 1996) and have greater impulse control (Baumeister & Heatherton 1996), need for structure (Neuberg & Newsom 1993), and self-monitoring (Snyder & Gangestad 1986) as compared to people in loose cultures. In tight cultures, people also find socially deviant behavior much less justifiable and have more ethnocentric attitudes (Gelfand et al. 2011).

To establish a causal link between ecology and psychological processes, we conducted a series of studies in which we made ecological and societal threats accessible in the laboratory. In one study, we tested whether high versus low population density would make people more or less tolerant of socially deviant behavior (e.g., taking drugs, having casual sex, littering, stealing, and talking loudly at a library). We randomly assigned participants to read one of the two versions of an article presumably to be printed in the local school newspaper. The article discussed how the campus of the participants' university is one of the highest (or lowest) in population density compared to other similar universities. The message was supported by statistical graphs and quotes of student life throughout the article. We then asked participants questions regarding social deviance and assessed ethnocentric attitudes. Consistent with the field data, those who were primed to think that their university campus has high population density were more likely to consider socially deviant behavior to be less justifiable than those primed with low population density. In addition, the measure of ethnocentric attitudes adapted from the Pew Global Attitudes Project (reported in Gelfand et al. 2011) showed that people primed with high population density were more likely to agree with such statements as “We should restrict and control entry of people into our country more than we do now”; “When jobs are scarce, employers should give priority to American people over immigrants”; “Our people are not perfect, but our culture is superior to others”; and “Our way of life needs to be protected against foreign influence” than those primed with low population density.

We conducted another experimental study on a different societal threat that we examined naturally in the field, namely, external threats to one's territory, and found similar effects. Participants were randomly assigned to read a school newspaper article, much like the one in the population density study, about a terrorist

threat warning system that was being implemented either at one's own university or at another university in a different country. Consistent with our field research on territorial threats (Gelfand et al. 2011), we found that individuals who were primed with threats to their own territory were much tighter than those primed with threats to another country's territory; they showed more ethnocentric attitudes and a stronger desire to punish social norm violators. They also showed greater implicit negative attitudes toward a socially marginalized group (i.e., overweight people) than a nonmarginalized group (i.e., slim people). As another example, we have expanded the ecological priming paradigm to examine additional threats (i.e., pathogens) using quasi-experimental designs. We approached individuals who were either about to see the movie *Contagion* (a movie about the spread of pathogens) or who had just seen the movie outside of movie theaters. As we predicted, people who had just seen the movie *Contagion* were much tighter; they had more negative reactions to social deviance.

In all, these examples of the ecological priming paradigm show that ecological conditions that form the macro basis of cultural differences across nations can be primed in the laboratory. Although experimental research has its own limitations, it can provide convergent evidence regarding the role of ecology in predicting psychological processes that complements correlational research reported in large-scale cross-cultural field studies.

What about politics and culture?

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Abstract: Given Van de Vliert's impressive dataset and prognoses, I will discuss three limitations. First, the evolutionary argument does not adequately take into account how political changes influence freedoms. Second, the operationalizations of needs and freedoms are limited and questionable. Third, a direct relationship between climate, monetary resources, and psychological variables is a simplification neglecting various intervening variables.

The highly relevant and interesting target article culled an impressive dataset from varied sources. Particularly innovative was the prognostics section relating climatic demands, monetary resources, and freedom for the year 2112.

The importance of history and political changes for freedoms. The main argument of the target article is that climatic demands and monetary resources explain the distribution of fundamental freedoms across the globe. Yet, countries develop, and their histories and current political systems also must be considered to understand individuals' freedoms.

For example, linking climatic demands and monetary resources directly to press repression seems odd when not taking political systems and practices into consideration. Van de Vliert wrote:

Press people were bullied most in poor populations threatened by demanding thermal climates (e.g., China, Sudan, Turkmenistan, and Uzbekistan), to a moderate extent in populations comforted by undemanding climates irrespective of income per head (e.g., Barbados, Honduras, Singapore, and Seychelles), and least in rich populations challenged by demanding thermal climates (e.g., Canada, Estonia, Slovakia, and Sweden). (sect. 4.2, para. 4).

However, political climate is likely to have stronger effect on repercussions against press than “demanding thermal climates.” Venezuela and Cuba do not have demanding thermal climates, yet press repression is high in both countries. Alternately, China, Sudan, Turkmenistan, and Uzbekistan, all discussed by

Van de Vliert, share characteristics of political repression and human rights violations.

Van de Vliert makes an evolutionary argument about the constraints and influences of climatic demands and monetary resources on several individual freedom variables. However, changes in individual freedoms on the country level can be very recent and very dramatic and mainly influenced by the dominant political system. In Germany, climatic demands have been roughly the same over the last centuries; monetary resources have varied considerably, such as the low point after the Great Depression in the 1930s, culminating in an unemployment rate of about 30% in 1932. Yet the fundamental freedoms of Germans can be undoubtedly attributed to the changes in the political systems from the democratic Weimar Republic (1919–1933) to the totalitarian era of Hitler and National Socialism (1933–1949) to the post-World War II federal parliamentary republic of West Germany (when average individual income was certainly very low). Dramatic changes in the political system are possibly stronger predictors of individual freedoms than climate and monetary resources, and can even influence access to monetary resources. The political system will affect wealth distribution and economic development; for example, in Russia, Spain, Italy, and Japan, especially over the last century, changes in freedoms were affected by changes in sociopolitical history.

Problems with operationalizing and assessing freedoms and needs. The article showed methodological shortcomings when operationalizing and measuring needs referring primarily to Maslow's hierarchy (1943; 1954; see also Alderfer 1972). According to Van de Vliert, the first group of needs, existential physiological needs, can be satisfied by freedom from want, defined as “enjoy a decent standard of living.” The only indicator used in this article was infant mortality. In 2011, the United States with an infant mortality rate of 6, i.e. 6 deaths per 1,000 live births, was behind 38 other countries who had lower infant mortality rates such as Portugal, Greece, Cuba, Cyprus, or Poland (United Nations Inter-agency Group for Child Mortality Estimation 2012). It is questionable whether citizens from these countries enjoy a better standard of living than U.S. citizens. What about other potential indicators of existential needs satisfaction, like access to and affordability of food or related indicators like hunger or poverty rate? What about access to affordable health care and housing?

The second group of needs, safety needs, would be satisfied through freedom from fear, defined as “no threats to personal security.” Freedom from fear was assessed by employee harassment and press repression. However, are these indicators relevant as threats to personal security within society in general? What about crime or murder rates, violence or bullying in schools? What about political instability, fear of war or terrorism or natural disasters? Or unemployment rates, job security, or labor laws and unions?

The third need, to belong and relate to others, would be satisfied by freedom of expression and participation and was assessed through self-expression goals. Self-expression goals emphasize the role of self-realization and would meet growth needs and are the opposite pole of survival goals emphasizing security. Self-expression alone does not adequately reflect the need to belong. What about divorce rates or loneliness, family belongingness or meaningful relationships? What about involvement in professional or vocational organizations or religious groups?

Similarly, the fourth (esteem and being respected) and fifth (self-actualization) groups of needs and freedoms were not adequately operationalized and assessed. One indicator for self-actualization was preference for democratic leadership among managers. But perhaps an Indian or Malayan middle-manager in a rural area fulfills his need for self-actualization more under a “nurturant-task participative leader,” who focuses on tasks, as well as affection and nurturing relationships (Sinha 2008), than under an employer demonstrating a democratic leadership style. To summarize, although it is difficult to operationalize how

these five groups of needs can be satisfied—especially the higher-order needs—the needs were assessed with a few variables that do not seem to adequately and validly reflect the breadth and core and, in some instances, the essence of the needs.

Something is missing. Again, the main argument of the article is to relate climate demands and monetary resources to psychological processes. An example sentence highlights this argument: “Greater [climatic] demands in interaction with insufficient resources to meet the demands increase closed-mindedness and risk aversion, whereas greater demands in interaction with sufficient resources increase open-mindedness and risk seeking” (sect. 2, para. 1). I would argue that something is missing between climate, money, and the psychology of people: open-mindedness in this case. People live in societies that have specific histories, cultural norms and rules, values, rituals, political forms, religious ideologies, and so forth. These factors are situated somewhere between climate and individual psychological processes and should be considered to explain behaviors (e.g., Berry 1997; Güss et al. 2007, on decisions of suicide terrorists; Güss 2011, on cultural values and decision making). Cultural influences are not adequately considered. Yet, culture is the blood and soul of a nation.

Unsurprising, in a good way

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Abstract: Van de Vliert associates a greater difference between upper- and lower-class freedoms under less favorable environmental conditions. This pattern is similar to models of the emergence of state-level hierarchies. I argue that Van de Vliert has provided a supportive strand to the history of ancient Near East religion.

My focus for this commentary is simply to place Van de Vliert's conclusions in the context of my own field(s): religion as seen from a cognitive anthropology perspective. In short, Van de Vliert's conclusions are unsurprising. What makes them particularly interesting is the method employed.

Anthropology, perhaps more than other disciplines, does not always rely on “chains” of evidence: if one metaphorical link is missing, we do not necessarily discard everything that follows. Rather, we rely on “cables” of evidence, in which distinct bodies of evidence serve as mutually supporting strands (Lewis-Williams 2002, pp. 102–3). This is particularly the case when attempting to reconstruct pre- and early history from fragmentary evidence. Over the past decade, models for biological and cultural evolution have increasingly been used to provide one such supporting strand (see Barkow 2006; Sperber 1996). (Though recently popular, this approach has a long history. Margaret Mead [1964] argued that not only does culture evolve, but the unit of evolution can include “types of social organization, from the simple band to the modern nation-state” [p. 146].)

Van de Vliert suggests anthropologists such as myself consider the above article as containing “evidence for the validity of models of niche construction” (sect. 6.1, para. 5), but I would like to address a more specific implication. A crucial event in the history of religion is the emergence of state-level societies, associated with new agricultural techniques, vertical hierarchies, kingship, and new forms of religion (especially doctrinal religions) (Whitehouse & Martin 2004). At the risk of repeating an already well-known narrative, one of the most robust of the traditional explanations for why this happened is ecological: in the Tigris and Euphrates valleys (as with the Nile, Indus, and Yellow rivers),

survival is disproportionately dependent on organized labor. The climate in the mid-fourth millennium BCE changed to a slightly cooler and drier environment. While mountainous regions still had ample rainfall for “wet” farming, lower altitudes could only be exploited with more intensive agricultural techniques, the most efficient of which being irrigation (see e.g., Nissen 1988, pp. 56–60). The labor necessary for intensive agriculture could not be sufficiently organized without centralized authority. Concentrating power in the hands of kings and priests may have decreased personal freedom for the majority (along with other costs associated with dense and sedentary settlement patterns), but the benefits of agriculture seem to have outweighed these costs.

Van de Vliert seems to have arrived at a similar pattern despite approaching it from a direction very different than scholars of religion. In less challenging environments, he sees differences in freedom between upper (in this case, richest) classes and lower (i.e., poorest) to be relatively small. In more challenging environments (colder or hotter than temperate), differences in freedom between classes are greater. This seems to parallel the differences between more egalitarian, wet-agriculture regions and hierarchical, dry-agriculture areas described by Nissen. In short, Van de Vliert has given the history of religions a supporting strand, and seems to have demonstrated that state formation in the fourth millennium BCE was simply a dramatic example of a more general pattern.

What is freedom – and does wealth cause it?

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Abstract: The target article’s climato-economic theory will benefit by allowing for bidirectional effects and the heterogeneity of types of freedom, in order to more fully capture the coevolution of societal wealth and freedom. We also suggest alternative methods of testing climato-economic theory, such as longitudinal analyses of these countries’ histories and micro-level experiments of each of the theory’s hypotheses.

Many of the most influential findings in behavioral science concern the power of situations to affect human behavior. Van de Vliert adds a novel and impactful dimension to these findings, showing how macro-level situational facets – climate and economic wealth – may combine to affect macro-level behavior, specifically the amount of freedom afforded by societies. The target article presents a provocative and interesting theory of how these basic ever-present situational factors shape our collective behavior, and there is insight gained by pushing a theory to its limits. It is convincing that the basic needs individuals seek to fulfill are partially a function of their environments. However, we question the causal order proposed by climato-economic theory and the precision of the theory’s conception of freedom.

Does freedom lead to wealth or does wealth lead to freedom?

Many modern economic theories (Florida 2002a; Glaeser 2011) reverse the causal direction proposed in the target article. According to these theories, history often shows that populations attain wealth as a result of the freedom afforded the population, which enables the free flow of cooperation and ideas, allowing human beings to create wealth through the efficient mixing of capital, talent, and comparative advantage. Thus, freedom may create wealth, rather than wealth creating freedom. Richard Florida

(2007), citing the economic boom in open-minded cities such as San Francisco and Austin, writes that “Freedom ... means the ability to be yourself and to follow your dreams. Open culture is a spur to innovation, entrepreneurship, and economic development” (p. 72).

Climato-economic theory proposes that climate challenges will “emphasize free choices inherent in stimulating opportunities and autonomous adventures” (sect. 2.4.2., para. 2) among the wealthy, but all of the supporting evidence for this claim is correlational (e.g. Van de Vliert 2007), such that it is entirely possible that wealth is a result of freedom rather than a cause. Given the longitudinal nature of the historical analysis of theories that posit that freedom leads to wealth (e.g., Florida 2012), more empirical evidence appears to suggest that freedom is a precursor to wealth in challenging climates, rather than a consequence. There do appear to be several rich countries in temperate climates that are repressive (e.g., Saudi Arabia, Brunei, Libya, and Iran), yet Middle Eastern countries, where wealth is a result of oil rather than having advanced economies, appear to be clear outliers. The data presented suggest that the presence of oil predicts oppression in wealthier nations far better than climate, providing a better fit to the data for countries such as Russia (see Crespo-Cuaresma et al. 2011 for more on the oil-dictatorship connection).

As such, more evidence for a causal link in rich countries is essential. Van de Vliert is on firmer ground with respect to the interpretation that threat appraisals lead to less freedom in demanding climates, as there is a large body of experimental research concerning the causal effect of threat appraisals on constrained thinking (Pyszczynski et al. 2003; Vail et al. 2012). We would be interested in similar experimental research showing that the ability to adapt to cold weather causes individuals to exhibit greater openness and free thinking.

Can all types of freedom be grouped together? Is there really broad consensus about what important freedoms are? Our research on American libertarians (Iyer et al. 2012) suggests that there is a wide gap between the positive conception of liberty espoused by liberals and the negative conception of liberty espoused by libertarians (see Berlin 1969 for a broader discussion of positive and negative liberty). Often, these freedoms are at odds with each other as the positive liberty to be free from want, facilitated by social welfare programs, often requires violation of others’ negative liberty to be free from economic interference in the form of taxation. The case of Singapore, which seemingly illustrates that temperate climates can be home to rich though repressive governments, is a clear example of the complexity of grouping these freedoms together: while Singapore is repressive socially, it scores quite high in ratings of economic freedom (Gwartney et al. 2008).

Van de Vliert groups these freedoms together in part because he supposes that most people seek to fulfill all needs simultaneously, regardless of economic circumstance, in contrast to researchers who have documented a progression toward the satisfaction of postmaterial needs as societies become wealthier (e.g., Inglehart 1997). In this case, we believe that the more parsimonious account, whereby lower-level needs must be satisfied first, provides a more theoretically accurate account as well. Maslow (1943) theorized that individuals must first satisfy survival needs before moving on the social needs, and Van de Vliert’s article shows that the poorer sections of China (the North) and the United States (the South) are more discriminatory than the richer sections. This rich/poor divide also maps onto the climate-based differences predicted by the target article. However, given that longitudinal evidence (Inglehart 1997) exists supporting the rich versus poor distinction and that, in the studies presented, monetary resources consistently accounted for more variance than climate and the climate-wealth interaction combined, in terms of predicting freedom, more direct evidence is needed to support the importance of nonmonetary factors. In particular, climato-economic theory would benefit from longitudinal evidence showing that individuals in temperate climates do not

seek to attain freedom of expression as much as individuals in demanding climates, even as these countries develop and wealth allows individuals to move up Maslow's hierarchy of needs.

In conclusion, climato-economic theory is a fascinating way of looking at how our macro-level environment shapes our collective behavior. As with any good theory, it provided an opportunity for us to think about the forces that shape our world. Yet, in considering those forces, existing theories of postmaterialism and the importance of creativity in producing wealth appear to have more explanatory power. We encourage behavioral scientists to examine longitudinal historical patterns and potentially conduct micro-level experiments that shed light on the processes involved and the directionality of the hypothesized effects, to further push climato-economic theory forward.

Extending climato-economic theory: When, how, and why it explains differences in nations' creativity

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Abstract: The climato-economic theory postulates mechanisms of threat and challenge to explain differences between countries. Interestingly,

both of these mechanisms are often considered to be components of the models of organizational climate for creativity. We show that among rich countries, climatic demands are related to creative achievement in a reversed-U manner, whereas the relationship is linear among poor countries.

In social sciences, climate reflects a metaphor that explains differences in human functioning (Litwin & Stringer 1968). Van de Vliert treats climate literally and exhibits how climatic demands themselves, and their interactions with nations' wealth, influence societies' needs and values. His theory offers some insights into explanations of higher-order aspects of human functioning. Deducing from the mechanisms proposed by Van de Vliert, we expected the climato-economic theory to predict differences in nations' creativity.

Creativity has several different forms: it can be frustration-based, which stems from threat (Heinzen 1994), or challenge-based, which breaks the status quo (Perkins 1988). Hence, both mechanisms caused by demanding climate could stimulate creativity. Theoretical models of organizational climate for creativity (Ekvall 1996; Karwowski 2011) and meta-analyses (e.g., Hunter et al. 2007) highlight the positive role of challenge and risk to creativity (effect size: 0.87 and 0.78, respectively; Hunter et al. 2007). Conversely, analyses at nations' level demonstrated that threats associated with destabilisation decrease creativity (Simonton 1990). Research on organizational climate suggests that the relationship between challenge and creativity is curvilinear rather than linear: increasing challenge translates into higher creativity, yet too challenging conditions are detrimental to creative production (Baer & Oldham 2006).

To date, economic variables were rarely involved in explaining creativity (Florida 2002b; Rubenson & Runco 1992), whereas climatic characteristics were completely ignored. Using Van de Vliert's data on climatic demands and monetary resources, we

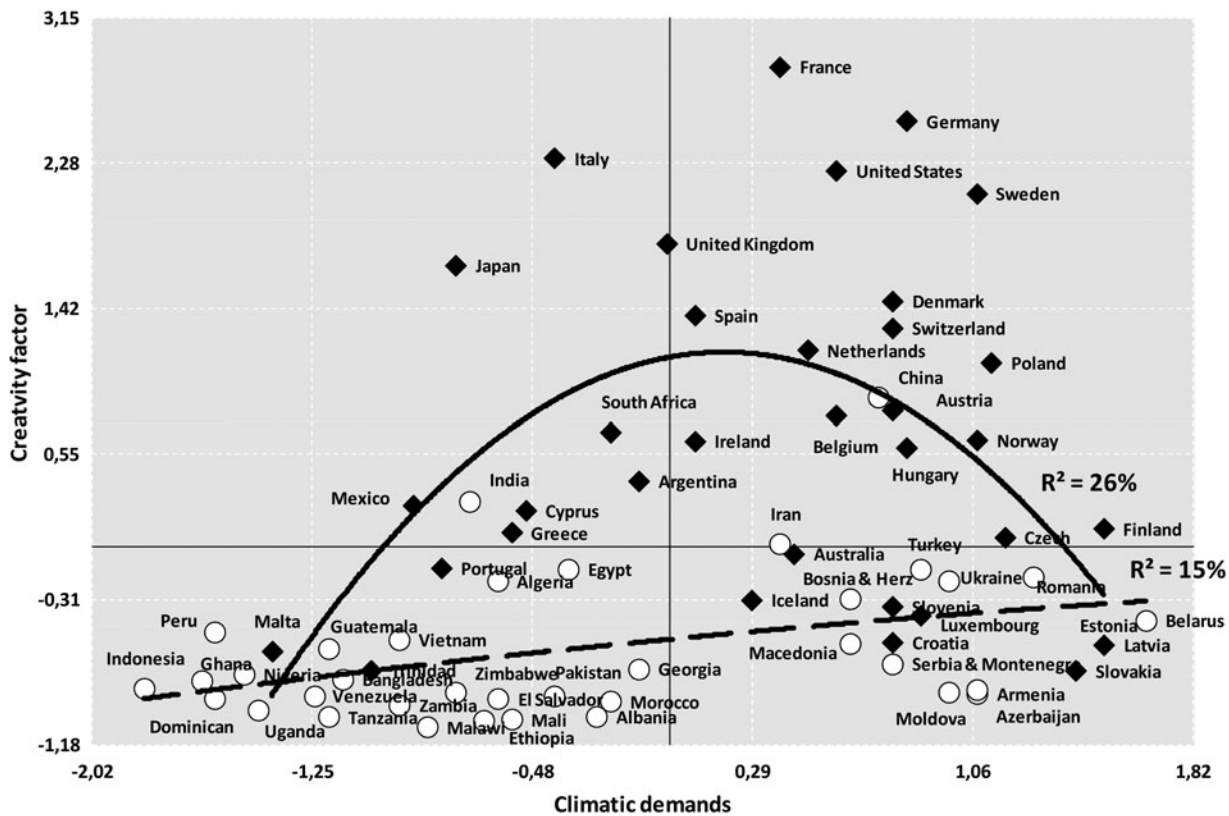


Figure 1 (Karwowski & Lebeda). Effects of climatic demands on nations' creativity moderated by monetary resources (curvilinear relationship shows the effect of challenge among richer countries; linear relationship is that of the threat among poorer countries). As a result of missing values, the sample was limited to 71 countries out of 85 analysed by Van de Vliert (83.5%).

examined whether these factors and their interaction could explain differences in nations' creative output. We operationalised creativity with the use of the measures of a nation's innovation potential (developed by INSEAD (Dutta 2012) and the Boston Consulting Group [BCG]) and indexes of creative achievements covering the arts (Nobel Prizes in Literature, Oscar Academy Award nominations and awards for international movies, and awards in World Design Rankings), sciences (Nobel Prizes in Science, a log of published scientific papers, and a H-index log), and the social world (Nobel Prizes in Peace).

Regression models explained between 0.5% (when H-index served as a dependent variable) and 79% (when INSEAD innovation score was explained) of the variance in creativity. Climatic demands reliably and positively predicted the INSEAD innovation index and Nobel Prizes in Science. Monetary resources formed a positive predictor in eight cases (all except the BCG innovation index, numbers of published scientific papers, and the H-index), whereas the interaction of climatic demands and monetary resources positively predicted the number of Nobel Prizes in Science and Peace, the number of published papers, and the H-index.

Factor analysis reduced the number of creativity variables to two groups. The first described "overall creativity score" and was composed of Nobel Prizes, Oscar and design awards, and INSEAD index, whereas the second was made up of scientific production: the number of published papers, citations rates, H-index, and BCG innovation score. The "creativity factor" was highly reliable ($\alpha = .88$) and interestingly related to climato-economic factors (Fig. 1).

When nations' population was controlled, the strongest effect was that of monetary resources ($\beta = .79$; $p < .0001$), whereas the effect of climatic demands was not reliable ($\beta = .08$). However, when we examined a possible curvilinear relationship, the squared term of climatic demands was indeed reliable ($\beta = -.15$, $p = .017$), showing decrease of creativity after some point. Climatic demands, their squared term, and monetary resources, together with nations' population, explained 76% of creativity variance. Interaction of squared climatic demands with monetary resources added significantly to the model ($\Delta R^2 = .02$) with a negative effect ($\beta = -.24$, $p = .03$).

In case of poorer countries, we noted a clear – albeit moderate – linear relationship between climatic demands and creativity. The more demanding the climate, the higher the country's creativity. The mechanism of threat seems to have a positive impact by motivating people to look for new solutions to their problems. In rich countries, the observed relationship reflects the pattern hypothesised in the theories of organizational climate for creativity (Karwowski 2011): the level of nations' creativity increases with the challenge generated by climatic demands, but decreases after achieving its optimum. Nations with the highest level of creative achievements are those of moderate (or slightly higher than moderate) climatic demands. This finding fits well with predictions deduced from the theories of organisational climate for creativity and challenges the assumptions of Van de Vliert's theory. The interaction between climatic demands and monetary resources that explains creativity does exist, yet its pattern is more complex than observed in the case of other variables described in Van de Vliert's article. On the one hand, the relationship observed in poorer countries is coherent with folk wisdom: under harsh conditions, creativity pays off. On the other hand, however, the level of creativity is generally low there; probably more important needs need to be fulfilled than engagement in creative activity. In richer countries, the observed relationship is even more interesting: moderate demands translate into the highest achievement, whereas too comfortable or too demanding conditions are similarly detrimental.

Further works should look for explanations for these findings. We can speculate that in richer countries not just challenge is important, but also values accepted in the society (Inglehart 2000), attitudes toward creativity (Florida 2002b), or uncertainty

avoidance (Hofstede 2001). When we repeated our analyses on thirty-five of the richest countries, introducing secular-rational values derived from the World Value Survey as a predictor, we found a marginally reliable association with the creativity level ($\beta = .36$, $p = .057$). The low power caused by a small number of countries (which were actually very similar: all except the United States and Australia were European countries, and all, without exception, belonged to the group of Western countries) calls for a more elaborated analysis in the future.

Methodological suggestions for climato-economic theory

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Abstract: To evaluate and extend climato-economic theory, the use of more micro units of analysis, such as cities and families, may open up new data sources. The consideration of environmental demands other than thermal climate may also broaden the range of useful data. Longitudinal designs can provide causal evidence, and so can experiments if the theory can be applied to individuals.

The climato-economic theory proposed by Van de Vliert is perhaps the most important recent addition to the line of eco-cultural theories (e.g., Berry 1976). Its development, however, is limited by two methodological challenges. First, support for the theory is primarily based on secondary country-level data on thermal climate and economic resources. Van de Vliert has exhausted most, if not all, of such data, and it is hard to collect primary data across many countries to advance the theory. Second, as with most cross-cultural research, it is difficult to establish causal claims made by climato-economic theory because thermal climate and economic resources are not amenable to experimental manipulation (cf. Leung & van de Vijver 2008). In this commentary, we propose some solutions to these challenges.

Cognizant of the challenge in data collection, Van de Vliert presents in his article two new studies based on a new approach. China and the United States are two large countries that have considerable variation in thermal climate and wealth across different regions, and thus they provide an appropriate, manageable research context in which to evaluate the climato-economic theory. With province as the unit of analysis in China and state in the United States, respectively, the predictions of climato-economic theory are generally supported. The use of state or province as the unit of analysis makes it easier for data collection. Indeed, the study in China is based on primary data collected specifically for testing this theory.

Extending this approach, we suggest that future studies consider more micro units of analysis. Climato-economic theory describes how psychobehavioral adaptations are shaped by thermal climate and economic resources in a shared habitat. Cities are shared habitats, and a large number of cities varying in thermal climate and economic resources can be sampled from a large country or from around the world to test and extend the theory. Likewise, members from a family face the same thermal climate and share the same economic resources. Families varying in wealth from different thermal regions may be compared to verify and extend climato-economic theory.

As highlighted by Van de Vliert, thermal climate is one of many forms of environmental demand. The evaluation and extension of climato-economic theory may be based on other environmental

demands, such as earthquakes, droughts, floods, and hurricanes. For example, the joint effects of tornado-proneness instead of thermal climate and economic resources across countries can be assessed. More micro units of analysis can be considered. An example is that the joint effects of tornado-proneness and wealth can be examined across states in the United States, in the same way as the joint effects of thermal climate and wealth are analyzed at the state level in the United States as reported by Van de Vliert. To broaden the data source, cities and families may also be considered in this line of studies.

Lack of causal evidence is the second methodological challenge confronting climato-economic theory. One way to establish causal inferences in cross-cultural research is the temporal contrast strategy (Leung & van de Vijver 2008). In the area of acculturation, there are longitudinal studies that track individuals who migrate from one culture to another over a relatively long period of time (e.g., Scott & Scott 1985). Following this approach, the study of families provides the possibility of longitudinal designs, as families may migrate across regions with different thermal climates, or exhibit drastic changes in their economic resources over time. Based on climato-economic theory, for example, a positive change in psychobehavioral adaptations would be observed among wealthy families that move from undemanding to demanding thermal climates. In contrast, a negative change in adaptations would be observed among poor families who go through the same climatic change. Such a pattern, if confirmed, will strengthen the causal support for the theory.

Experimentation is another way to strengthen causal inferences in cross-cultural research (Leung & van de Vijver 2008). The processes underlying the impact of culture-level variables may not be equivalent to processes at the individual level. Leung and Bond (2008) use the term *eco-logic* to refer to the rationale behind culture-level theories, and the term *psycho-logic* to refer to the rationale behind individual-level theories. If the *eco-logic* of a culture-level theory can be meaningfully translated into *psycho-logic*, one may test the theory at the individual level using a variety of designs, including surveys and experiments (Leung & van de Vijver 2008).

Van de Vliert states that climato-economic theory belongs to a family of demands-resources theories, which includes the transaction model of stress (Lazarus & Folkman 1984), an individual-level theory. If the processes underlying climato-economic theory can be translated into *psycho-logic*, the theory can be evaluated at the individual level. For example, experiments can involve individuals coming from either demanding or undemanding thermal climates, who are provided or primed with either high or low economic resources (cf. Cohen et al. 1996). Climato-economic theory would predict that the psychobehavioral responses of the individuals coming from demanding thermal climates would be more positive in the rich-resource condition than in the poor-resource condition, whereas the responses of the individuals coming from undemanding thermal climates would not vary as a function of the availability of economic resources.

It is possible to manipulate thermal climate by subjecting individuals to high, low, or moderate temperature for a relatively long period. This type of experiment sounds unusual, but is not inconceivable. For example, in a sleep study, a cycle of 32.85 hours of scheduled wakefulness and 10 hours of scheduled sleep was repeated for 21 calendar days (Cohen et al. 2010). If thermal climate and economic resources do not require a long period to show their effects, experiments of this nature can provide causal evidence for climato-economic theory.

To conclude, the development of climato-economic theory is confronted by two methodological constraints. We propose several approaches to facilitate its empirical substantiation and extension, and the need to consider the possibility of applying this culture-level theory to individuals. We hope that our comments will leapfrog the development of this intriguing eco-cultural theory by identifying several productive avenues for future research.

The need for psychological needs: A role for social capital

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Abstract: Van de Vliert embraces a “supply side” model of human needs, underplaying a “demand” model whereby individuals, motivated by psychological needs, develop coping strategies that help them meet their personal goals and collectively exert an influence on social and economic systems. Undesirable climates may inflate the value of financial capital, but they also boost the value of social capital.

We see merit in aspects of Van de Vliert’s focus on human needs but disagree with several of his more important claims. For one thing, he holds that human needs are largely satisfied according to economic and climactic variables that are featured in an environmentally oriented “supply side” model. According to that model, physiological needs are satisfied by the availability of resources (“freedom from want”), safety needs are satisfied by the absence of threat (“freedom from fear”), needs to relate are satisfied by “freedom of expression and discrimination,” and so on. Though Van de Vliert conflates psychological needs and sociopolitical and economic needs, our concern is that his emphasis on exogenous factors, including the “freedom” and “opportunity” to act, places too much stress on the environment-as-cause. For one thing, to get where Van de Vliert wants to go, he also needs a psychologically oriented “demand” system in which individuals—far from being passive recipients who operate solely at the mercy of external factors—actively cooperate and compete with each other for resources.

For Van de Vliert, a human need is “a deprivation that energizes a drive to eliminate or reduce the deprivation” (Van de Vliert 2009, p. 37; sect. 1, para. 3) but there is little or no reference to the function of the needs. By contrast, we see psychological needs as species-specific causal mechanisms that motivate individuals to take certain classes of action that, unless ineffective or socially thwarted, will typically satisfy their needs and thereby facilitate competition for environmental resources. Our assumption is that psychological needs such as autonomy, connection, and stability evolved in response to problems that arose when our evolutionary ancestors increased their reliance on social solutions to biological problems, and that these adaptations may therefore be characterized as evolved psychological mechanisms (Flanagan 2010; Locke 2008; Locke & Flanagan 2011).

In Maslow’s *hierarchical* model of needs, which Van de Vliert embraces, physiological needs develop first and, once developed, must be met before psychological needs can be satisfied. What would be more appropriate is an *operational* model, one that is both functional and sequential. On such a model, connection and other psychological needs that advantageously position individuals with respect to potentially helpful others are the primary means of achieving biological goals. For example, in the process of satisfying their need for connection, individuals stand to benefit from social mechanisms, such as social observation and cooperation, which facilitate attainment of nutritional, safety, and reproductive goals (Locke & Flanagan 2011).

Exogenous models pose other problems. When individuals attempt to satisfy their psychological needs, they exert an influence *collectively* on the social and economic systems of their culture. This collective action indirectly reflects the operation of needs as causal mechanisms, but it also directly reflects the strategies individuals use to meet their needs. It’s not enough to be *free* to relate. You have to *want* to relate and to have the where-withal—the knowledge, ability, and skill—to go about relating

effectively. This presupposes the ability to apply successful coping modes (Flanagan, *in submission*).

Van de Vliert claims that extreme climates influence economic strategies because they enable people to buy things that minimize ill effects. Perhaps they do, but there are reasons to doubt a regular or even rational relationship between climate and financial expenditure. Some years ago Amos Rapoport (1969), an architectural anthropologist, observed no predictable connection between the weather and the security or even the existence of housing in various places around the world. Rapoport noted that in mild or warm climates dwellings were often quite elaborate, whereas in frigid ones housing was virtually nonexistent, even though the people had the ability, tools, and materials to build. He termed the relationship between climate and housing patterns “irrational,” and other anthropologists agreed.

So what are the social implications of a well-formed psychological need and a promising coping mode? Consider two individuals, one who is intent on satisfying a need for autonomy. In a traditional society, he may do this by proving himself to be the best hunter in the village. Because sharing is a strongly held value in such societies, this hunter stands to appreciate important *social* benefits, including sex and dominance, by giving away the nutrition he has secured rather than consume it himself (Smith 2004).

Now consider a member of a traditional society who is attempting to satisfy a need for connection. By forming relationships with others, this individual will find himself positioned to share with them not only what they own but also what they know and are able to do. If potential allies are appraised accurately and befriended strategically, many will have what the sociologist James Coleman called “human capital,” some form of knowledge or skill that has practical value. Those who are able to draw on these resources, perhaps because they can be trusted to return favors, have “social capital,” which can be used to achieve important biological goals for, say, food and personal defense. Though it “exists in the *relations* among persons,” according to Coleman (1990), social capital can be worth far more than the physical kind that we keep in our wallets. It is partly for this reason that individuals are judicious in their selection of friends.

Van de Vliert is aware that inhabitants of tropical climates typically face the threat of illnesses not found in more temperate climates, and he sees money as a helpful resource in dealing with problems associated with tropical living. But some of these problems may be addressed socially too. In recent years, a number of studies have obtained evidence of an adaptive trend toward collectivism, and xenophobia, in hot climates with high levels of pathogens (Faulkner et al. 2004; Fincher et al. 2008; Gangestad et al. 2006; Navarrete & Fessler 2006; Schaller 2011; Schaller & Murray 2008). If the weather can indirectly cause people to avoid strangers—a coping strategy rendered socially—it’s not just the availability of financial capital that counts.

Toward an integrated, causal, and psychological model of climato-economics

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Abstract: Van de Vliert puts forward a model of how climate and economics interact to shape human needs, stresses, and freedoms.

Although we applaud the construction of this model, we suggest that more needs to be done. Specifically, by adopting a multi-level and experimental approach, we can develop an integrated, causal, and psychological model of climato-economics.

Van de Vliert argues that climato-economic conditions influence human needs, stresses, and goals, leading to differences in freedoms. This model can be praised on many dimensions; for example, scope, innovation, cross-disciplinary perspective. However, it contains a serious omission: evidence for a direct, causal link between climato-economics through individuals’ psychology to collective freedoms. The major issue concerns the failure to measure and model individual-level processes, which ultimately means that the current approach cannot establish causality. We propose that these shortcomings can be overcome by using emerging multi-level and experimental techniques. We believe that doing so would allow the development of an integrated, causal, and psychological model of climato-economics.

Van de Vliert focuses on collective freedoms, and so a collective-level approach focusing on regions or nations may appear entirely justified. However, the intervening psychological processes linking environments to freedoms—needs, stresses, goals, and means—are clearly individual-level attributes and should be measured as such. Further, many of the “collective freedoms” are aggregates of individuals’ behaviors (e.g., security, discrimination, longevity) rather than attributes of societies per se. For these two reasons, a strictly collective-level approach is incomplete.

Although some evidence provided by Van de Vliert is situated on the individual level, much of it relies on correlating climato-economic variables with national or group aggregates of psychological variables. Although this is certainly informative, it does not necessarily speak to how these variables affect individuals. Indeed, relationships obtained across nations or groups need not coincide with relationships found between- or within-individuals (cf. ecological fallacy). Unfortunately, it is exactly at the between- and within-individual level that most phenomena and predictions addressed by Van de Vliert take place; for example, how (changes in) climato-economics influence (changes in) individuals’ needs, stresses, and goals. This causal chain—from environments through individuals to freedoms—is critical to the theory but not tested using the current approach.

Failure to examine the individual also blinds the theory to the potentially critical divergence between the objective climato-economic environment and the *perceived* environment. As Van de Vliert notes, resource-demand theories depend on how people appraise their environment, rather than the objective environment itself. Subjectively appraised and objectively measured environments will be related, especially at the extremes; however, just as subjective socioeconomic status predicts health over objective socioeconomic status (cf. Singh-Manoux et al. 2005), understanding and measuring how individuals appraise their environment can add predictive ability to the model. Both an appreciation of within- and between-person processes and the role of perceived environments require an integrated individual-level approach.

The use of collective-level regression means that causality is frequently inferred rather than tested. Although it is only somewhat true that people create their climate, people clearly create their economy; and economic conditions explain the majority of variance in freedoms either independently or via interaction. For this reason understanding the causal direction of climato-economic effects is important for the robustness of the theory. Additionally, the causality problem undermines the series of predictions forwarded by Van de Vliert, and these rely on a genuine, causal relationship between the variables. If climato-economic conditions are associated with—but do not cause—differences in freedoms, climato-economic changes may not have the predicted effect.

One way to address these problems is to routinely adopt a multi-level approach that examines how climato-economics influences

individuals' psychology and how that in turn influences freedoms. Inferences at the level of the individual require a multi-level approach in which between- and within-person variables are examined as a function of climato-economic factors. Such a model could move beyond noting that needs, stresses, goals, and freedoms are mutually related at the individual level to model how this relation is a function of climato-economics. It could reveal whether environments do indeed shape needs, stresses, and goals, which in turn favor specific freedoms. Further, it could easily integrate objective environments at the collective level with subjectively perceived environments at the individual level.

Within-person analysis would additionally allow researchers to test how psychological variables change across time within individuals. Climate and economics change across the era, year, and even day. The climato-economic model can be examined across a range of timespans (from decades to hours) to explore whether climato-economics change needs, stresses, and goals from one moment to the next. These time-lagged models would be better suited to establishing directional or causal relationships than models that look at "snapshot" associations (see, Granger 1969; Sugihara et al. 2012). Recent work has employed multi-level and time-lagged approaches to explore the role of economics in human psychology. For example, regional differences in self-enhancement (Loughman et al. 2011), happiness and trust (Oishi et al. 2011; 2012), and dishonesty (Neville 2012) have been explained by economic differences across nations, regions, and time. Testing the climato-economic model in a similar way can allow for stronger inferences while accounting for between- and within-individual effects.

The core tenets of climato-economics are increasingly tractable to experimental psychology. Recently, social and evolutionary psychologists have manipulated perceptions of environmental resource availability and examined the effects on social judgments. It is now established that changes in perceived resources cause changes in female mate selection (Hill et al. 2012) and intergroup perceptions (Rodeheffer et al. 2012). This latter finding experimentally corroborates the ingroup favoritism effects detailed by Van de Vliert, albeit without exploring the role of climate. By manipulating climatic demand and resource availability, and then measuring needs, stresses, goals, and freedoms, we can develop a causal model of climato-economics that complements a broader survey-based approach.

To conclude, we very much like the climato-economic model. It puts forward a coherent and powerful theory for understanding the geographic distribution of freedoms. We respectfully suggest two ways in which the model can be expanded; by integrating collective- and individual-level variables and by establishing causality through the use of time-lagged and emerging experimental techniques. Adopting these two future directions will enhance our ability to both understand and predict differences in freedoms across regions and individuals. We believe that by doing so the climato-economic model can be expanded to reflect an integrated, causal, and psychological account.

Cultural adaptations to the differential threats posed by hot versus cold climates

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Abstract: Hot and cold climates have posed differential threats to human survival throughout history. Cold temperatures can pose direct threats to survival in themselves, whereas hot temperatures may pose threats

indirectly through higher prevalence of infectious disease. These differential threats yield convergent predictions for the relationship between more demanding climates and freedom of expression, but divergent predictions for freedom from discrimination.

Van de Vliert's target article notes that cold and hot conditions pose divergent problems, which entail unique psychobehavioral adaptations. Exactly what these divergent problems are, and the unique psychological and cultural adaptations they are likely to cause, deserve further exploration. Distinct logical hypotheses predict that hot and cold climates will lead to convergent cultural adaptations for some of the freedoms that Van de Vliert discusses, and to divergent cultural adaptations for others.

The ancestors of modern humans evolved largely in equatorial regions, which consisted of both temperate and "hot" climates. It is most likely that only the control of fire allowed humans to expand to colder climatic zones (e.g., Burton 2009). The adaptive problems posed by very hot and very cold temperatures thus vary in their immediacy. The threat posed by cold temperatures is much more direct and immediate than the threat posed by heat; void of thermal technology, a very cold climate is a much more immediate threat to survival than a very hot one.

Hot climates, on the other hand, pose a suite of indirect adaptive challenges. One substantial challenge to survival in hot climates is not heat itself but infectious diseases, which proliferate in hotter climates (Epstein 1999). Infectious diseases have likely caused more deaths than predators, natural disasters, wars, and noninfectious diseases combined (e.g., Inhorn & Brown 1990) and have been a key selective force in the evolution of human physiology and culture (Armélagos & Dewey 1970; Black 1975).

The causes of mortality in traditional societies reflect the differential threats posed by hot versus cold weather: whereas infectious disease causes more than half the deaths in traditional post-contact equatorial cultures (e.g., Gurven & Kaplan 2007), leading causes of death among circumpolar traditional cultures (such as the Inuit of Canada or the Sámi of Scandinavia) involve noninfectious ailments, many of which may be the result of diet (Hassler et al. 2005; Peters 2010). The different adaptive problems that drive cultural and genetic evolution in these disparate climates suggest divergent logical predictions about how these climates affect certain freedoms.

Let us first consider the utility of conformity (low "freedom of expression") in hot climates. Whereas unequivocal conformity to cultural norms can have costs (e.g., it inhibits innovation), it has anti-pathogen benefits: many cultural prescriptions (especially those pertaining to hygiene, food, and sex) serve to buffer against pathogen transmission (e.g., Fabrega 1997). These anti-pathogen benefits should be especially likely to outweigh the costs of conformity when the threat of disease is especially high. The implication is that the resultant higher disease threat in hotter climates should negatively predict freedom of expression. Several lines of research support this hypothesis. Conformity and obedience are highest in cultures characterized by higher disease threat (controlling for monetary resources), higher for people who are dispositionally more worried about the threat of disease, and higher when disease threat (but not non-disease threat) is temporarily perceptually salient (Murray & Schaller 2012; Murray et al. 2011; Wu & Chang 2012). Therefore, disease threat may mediate the relationship between hot climates and lower freedom of expression (at least in countries lacking monetary resources to buffer against this threat).

Just as some cultural norms buffer against harm from pathogens, other cultural norms may buffer against the immediate threats inherent in very cold environments. Deviating from established norms in cold environments could pose immediate challenges to survival (e.g., norms pertaining to methods of thermal protection or to fire preparation and maintenance). To date no study has uniquely investigated the impacts of cold-based threats on conformity. However, despite the different adaptive challenges posed by these climates, the logical predictions converge for their cultural consequences: freedom of expression should be especially costly in both hot and cold (low monetary resource) environments.

Ethnocentrism and xenophobia (“freedom from discrimination”), on the other hand, may produce divergent predictions between different extreme climates. Disease threat has implications for xenophobia: The immune system is calibrated to pathogens common within one’s ingroup, and contact with non-ingroup members increases the probability of exposure to novel pathogens. Drawing on a cost/benefit framework, the implication is that xenophobia is more beneficial – and thus more prevalent – when pathogen threat is especially high (e.g., in hotter climates). Indeed, group assimilation is negatively predicted, and xenophobia positively predicted, by higher disease threat (Fincher & Thornhill 2008; Schaller & Murray 2010). Xenophobia is also higher when disease threat is perceptually salient, and when the immune system is temporarily compromised (Faulkner et al. 2004; Navarrete et al. 2007). Therefore, the covariation between demanding hot climates and lower freedom from discrimination is likely to be driven, at least in part, by variation in disease threat.

Predicting the relationship between more demanding cold climates and xenophobia is less clear. There are still benefits of xenophobia in very cold climates (e.g., lower probability of interactions with those who are more likely to violate local norms, Kurzban & Leary 2001); however, the benefits of outgroup contact in cold climates (trade and better resource stability, large-scale cooperation) may outweigh the costs in these low-disease environments. Therefore, the opposite prediction that more demanding cold climates predict lower xenophobia is equally feasible, and demanding hot and cold climates make divergent predictions for freedom from discrimination.

The feasibility of analyses investigating the interrelationships between disease, climate, and monetary resources is constrained by the strong relationship between temperature and wealth; cold rich countries far outnumber cold poor ones, and hot poor countries far outnumber hot rich ones. This relationship is also at least partly attributable to variation in disease, given the bidirectional causal relationship between disease prevalence and wealth (e.g., Gallup & Sachs 2001). As the target article notes, single-factor explanations of culture are myopic; in fact, the state of the literature is now such that we can extend beyond two-factor explanations as well. The next step in this research will be to investigate and test structural models of the interrelationships between causal ecological variables and their impact on the evolution of cultural differences.

Contextual freedom: Absoluteness versus relativity of freedom

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Abstract: Our commentary is focused on the idea that “freedom” takes on its full significance whenever its relativistic nature, in the short- and long terms, is taken into account. Given the transformations brought about by “globalization,” application of a general model of freedom based on ecological-economic factors clearly seems to be rather untimely. We examine this idea through egocentric and ethnocentric views of the social and environmental analyses of “freedom.”

In his article, Van de Vliert applies the appraisal theory (Lazarus & Folkman 1984) in an attempt to explain unevenly distributed fundamental freedoms, thereby suggesting that people’s needs, and freedoms of all kinds are caused by climate-economic-based

habitats. However, it is doubtful that humans mindlessly adopt every goal imposed by these habitats, because people often have their own guiding preferences and motivations. Human reality is mostly social. Social contexts and motives construct human thoughts and behaviors (Smith & Semin 2004). The reality of subjective meanings is anchored in its socially shared nature (Smith & Mackie 1995). Social verification transforms subjective experiences into objective realities, a process that has costs and benefits. To survive in any social unit, people must possess a mental compass for navigating through role-rule structures in terms of accountability demands, control, and moral backstops (Tetlock 2002) that make them receptive to social and ecological-economic factors.

However, certain cognitive-motivational mechanisms might lead people to resist external influences. Situational demands involving potential costs/benefits do not always cause people to pursue goals, especially when they are held by others. Rather, people sometimes spontaneously shield themselves from others and even counteract others’ implicit motivational influences (Leander & Chartrand 2011). The magnitude of their resistance depends on competing goals, current situational demands, and the available mental-social resources. This flexibility in people’s momentary sensitivity to others’ influences suggests that they have their own motivational priorities. Sometimes, however, goals become more socially shared when they become associated with a sense of urgency, and this may lead individuals to temporally shift their priorities. For example, perceiving that an ingroup member is seeking to attain an important goal may lead individuals to pursue that goal themselves – as long as it suited their own motivational priorities.

Just as egocentrism is the tendency to judge oneself as superior to others, ethnocentrism is the parallel tendency to judge one’s group as superior to other groups. Because these judgment differences include perceived values and goals, shared reality within ingroups increases the likelihood of conflict with outgroups, but also intensifies loyalty to those ingroups. Such egocentric and ethnocentric biases occur in cultural settings, which will determine the full meaning of an event-behavior. For example, in highly interdependent cultures, withdrawal from an interaction might be defined more as expression of anger than it would be in an independent social environment (Mesquita & Markus 2004). Similarly, in interdependent cultures, interfering with fights among children is prohibited because fighting is believed to lead to the development of empathy. In independent cultures, on the contrary, a lack of intervention is a sign of neglect. By the same token, although interdependent cultures consider voluntary actions as a response to social roles, in independent cultures they are considered as expressions of individual preferences (Markus 2008).

Taken together, a question arises: What are the origins of cross-cultural differences? Because cultural rules are accumulated over generations, this question is historical in nature and it is impossible to find out which factors have played a real part in their development. Much research has focused on the relationship between a variety of ecological and economic factors, in an attempt to explain cross-cultural variation in terms of independence/interdependence or individualism/collectivism (e.g., Fincher et al. 2008; Triandis 1995). However, living conditions, territorial rooting, and so forth, are necessary but insufficient conditions for determining cross-cultural differences. Social distance (population density, social and economic standing) call for abilities to manage the presence/absence of others, and to build connections based on contextual characteristics related to different scales (localization/globalization) and dimensions (territory/network; Moser 2009).

There is therefore no doubt that in the self/ingroup relationship “need-based stress appraisals and choices of goals, means and outcomes are...converging into a pattern of...behavioral choices [that] can be more or less...routine, thus unfree, versus more or less autonomous and adventurous, thus free” (sect. 2.4.1, para. 2). However, as rich and interesting as is the very large research literature reported by Van de Vliert, the question about the India paradox remains open. In 1948, India was struggling for its independence and survival. Through its collective coexistence

(different faiths, languages, cultures), India was not expected to survive as a democracy. However, against the logic of human history, India's economy grew and now ranks eleventh in the world for GDP and fifth in purchasing power parity. But according to the Human Development Index, India is 119th out of 169.

Clearly, freedom is a slippery concept, and as such it is difficult to take a stand or even move on, because in addition to being an idyllic state, the meaning of freedom changes according to the perspective taken and the context in which such an idyllic state comes to mind. Considering freedom without looking at its contextual nature could mistakenly lead to the assumption that one is dealing with some kind of "absoluteness." The absoluteness of such concepts makes their use psychologically meaningless; their contextualized understanding reveals their dynamic nature. Human psychology is about meaning, which emerges from moment-by-moment recursive transactions with the external world (Mischel & Shoda 2010). Freedom of all kinds takes on its full significance whenever its relativistic nature, in the short- and long terms, is taken into account. Freedom from certain needs and fears depends on the situational urgency, whereas absoluteness of those freedoms is recklessness. Context-free moral judgments and decisions are often based on universal moral principles. However, the same judgment and decision can be rooted in other considerations, depending on which aspects of the current context are taken into account. Self-indulgence or self-derogation of moral principles may be facilitated by highly demanding physical environments. Demanding climates may provide a solid justification for some kinds of misconduct. Notwithstanding, insofar as it is true that "all living species evolve links between their natural habitats and their natural habits" (sect. 1, para. 1), it is also true that the demanding or undemanding nature of the climate and its changes gradually trigger long-run changes in all living beings, particularly humans, and that situations, cultural, ecological, or/and economical environments exist by virtue of the people who constitute them.

Shared adaptiveness is not group adaptation

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Abstract: Climate stresses and monetary resources seem to lead to different collective adaptations. However, the reference to adaptation and to ambiguous collective dimensions appears premature; populations may entertain nothing more than shared adaptiveness. At this point, the intricacy of the underlying evolutionary processes (cultural selection, fitness-utility decoupling) very much obscures any diagnosis based on correlations.

When talking of adaptation in a population, two distinctions are crucial. First, to be adaptive is not to be an adaptation. A trait is adaptive in a given environment if it provides a fitness advantage. An adaptation is a trait that has evolved because it provided such an advantage—its effect is the cause of its fixation in the population. Adaptiveness and adaptation are neither necessary nor sufficient for one another. An adaptive trait may not be an adaptation if it just happens to provide a fitness advantage in an environment; an adaptation may not be adaptive when an environmental change has made it suboptimal. (Sober 1993)

Second, there is a difference between shared individual adaptations and group adaptations. A trait is a shared individual adaptation if it is present in all members of the population but evolved

because it provided fitness advantages to the individuals (e.g., fast running for cheetahs). A trait is a group adaptation if it evolved because it provided fitness advantages to the group (functional organisation or division of reproductive labour in ant colonies are likely examples). In Williams' (1966) famous terms, a fleet herd of deer is not a herd of fleet deer.

Does the set of climatic and wealth conditions lead to "psycho-behavioural adaptations," and if yes of what kind? First, within the "cultural syndromes," appraisals are not adaptations, as they simply report the situation's characteristics; and saying that agents have goals is just another way to express the nature of their dominant needs. By contrast, means and outcomes (agency and organisation) are possible adaptations.

Modes of agency and kinds of organisation may seem as genuine adaptations, but only because adaptiveness and adaptation all but collapse when the relevant evolutionary processes are mostly cultural. The original motivation for the concept of adaptation is the surprising fit between phenotypes and environments, given that the underlying genotypes mutate randomly, without aiming at a target. In cultural selection, however, most processes are target-driven: efficient solutions spread because they are recognized as such and copied (Claidière & André 2012). Constant mention of "adaptations" suggests a rich, intricate evolutionary past of cumulative selective pressures; but in the context of cultural selection, current success suffices to do the job—especially if money can be substituted to skill. In this sense, cultural selection trivialises adaptation.

Let us grant that these psychobehavioural traits are adaptations. Are they individual or group adaptations? The target article repeatedly mentions collective aspects—collective freedoms, collective stresses, collective meeting of climate demands, collectives adaptively responding to environmental necessities—that smack of group adaptationism. However, climatic stresses are shared constraints: they affect everyone similarly, and the collective cost is nothing than the average of individual costs. All agents may adapt individually to these stresses.

What could make these adaptations collective? Is it the collective habitat appraisal, that is, the activity of "pushing and pulling each other" towards shared solutions, that is, a shared culture? At best, discussion and mutual influences can only lead to a convergence of a range of individual solutions towards a unique one. However, it will still not have appeared because it benefits the group, but only because it benefits each individual.

One key argument may be that if climate and monetary resources shape cultures, and cultures are typically shaped by group selection (as they are taken to benefit the group as a whole), then at least *some* climate constraints and monetary resources can drive group adaptations—recent doubts about the importance of group selection in shaping human culture notwithstanding (Pinker 2012). Indeed, the signs of group selection are manifest in the collectivist societies (with high ingroup bias, outgroup derogation) found in threatening environments, and absent from these found in merely challenging ones.

However, recent work on group identification (Postmes et al. 2005), an important psychological factor of cooperation and a likely product of group selection, suggests that it can be triggered by shared similarities *but also by individual distinctiveness*. The picture is even more complicated by the fact that autocratic organisation is not a characteristic of egalitarian hunter-forager societies, considered as theoretically ideal targets of group selection. In other words, the presence or absence of group selection, and thus the possibility of group adaptations, does not straightforwardly depend on the characteristic of societies emerging under climate-monetary kinds of environments. This need not worry us: whether a trait is a group adaptation crucially depends on causal factors, which makes the insufficiency of correlations unsurprising (Okasha & Paternotte 2012).

To summarise: The target article seems to lead to the conclusion that group adaptations can arise in threatening climates and shared adaptiveness in challenging climates. However,

group selection actually crosscuts these climate categories: its absence or presence is not necessarily constrained by them.

Lastly, money can allow agents to cope with climatic stresses only if agents do care in priority about their existence needs. But evolutionary theorists (e.g., Sterelny 2012) have stressed that environment changes, including cultural change, tend to decouple individual utilities from fitness. If social evolution has made us pay disproportionate attention to social needs, then the increased freedom of choice enjoyed by members of rich societies could lead to a worse population-level state than should be expected by the target article's interpretation. Contrary to an early assumption of the target article, the appearance of new needs may well dwarf old ones. In other words, the various needs that drive the selection of behaviours cannot be straightforwardly juxtaposed, which impacts the adaptations we should expect.

So for several reasons, the evolutionary process at work behind the fascinating correlations discovered by Van de Vliert is likely to be much more complex than the target article hints, and possibly less influential on culture in general, which in turn is relevant for the inferences drawn about future trends. In any case, the premature resort to a notion of (collective) adaptation is likely to obscure the debate.

Fundamental freedoms and the psychology of threat, bargaining, and inequality

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Abstract: Van de Vliert's findings may be explained by the psychology of threat and bargaining. Poor people facing extreme threats must cope by surrendering individual freedom in service of shared group needs. Wealthier people are more able to flee from threats and/or resist authoritarianism, so their leaders must concede greater freedom. Incorporating these factors (plus inequality) can sharpen researchers' predictions.

Van de Vliert argues that extreme climates have different effects on rich and poor nations, "pushing and pulling" toward freedom in rich groups and toward repression in poor groups. Accordingly, he finds that discrimination, workplace bullying, autocratic leadership, press repression, and reduced freedom of self-expression are (1) most severe where people with low average income face extreme climates, (2) least severe where people with high average income face extreme climates. Our goals in this commentary are to show that this pattern of results is well explained by the individual-level psychology of threat and bargaining and to highlight the importance of inequality as a macroeconomic variable predicting freedom outcomes. In doing so, we hope to encourage synthesis of related theory and findings in different disciplines, leading to improved models.

Van de Vliert emphasizes that humans must cope with climate-related threat by using available resources, including money and the support of one's social group. Poor people facing severe threats they cannot escape have no choice but to form very tight groups to meet shared needs. It is well established that group solidarity is higher when members face a common threat (reviewed by Benard & Doan 2011; Van Vugt et al. 2008); such effects are even found in nonhumans (Radford 2008). Group members have a stake in each other's well-being, so it pays to cooperate in order to address such mutual threats (Lahti & Weinstein

2005; Roberts 2005; West et al. 2007). As part of this general phenomenon, group threats also cause people to conform to group norms and increase their support for existing leaders (Van Vugt 2006; Willer 2004); leaders may in turn exaggerate such threats to promote cohesion and suppress attempts to supplant them (Lahti & Weinstein 2005; Willer 2004). The greater the threats, the more group members need to unite. (To avoid confusion about terminology, note that where we would say "minor threat," Van de Vliert says "challenge.") This research is consilient with Van de Vliert's findings that the people facing the most extreme climate threat with little means of escape (those in poorer countries with extreme climates) enjoy the least individual freedom.

Extreme climates are associated with reduced freedom among poor nations, but greater freedom among rich nations (according to the target article). This interaction may be because rich people confronted with threats have an option besides coping: avoiding the threats altogether. For humans confronted with a threat that is directly and permanently linked to their location (or social group), fleeing from threat will typically require relocating and/or joining a new group. Whether for purposes of coping or fleeing, earning the support of a social group is a bargaining process whereby individuals must make contributions and/or concessions in exchange for access to group benefits that are disproportionately controlled by the most powerful members of the group. When shared conditions are good and group members have many outside options, subordinates have more resources available to challenge dominants and pose a more credible threat to leave; thus, dominants must concede more to subordinates to entice them to stay in their groups. Predictions based on this logic have been supported in behavioral ecology by numerous mathematical models and empirical studies of inequality within nonhuman species, where it is called "reproductive skew theory" (e.g., Johnstone 2000; Shen & Reeve 2010). Psychology experiments have shown that when people think emigrating is easy, they are less supportive of the local political system (Kay et al. 2009; Laurin et al. 2010).

We suggest that residents of nations with low average income are less capable of bearing the costs of relocation and bring less bargaining power to efforts to join a new group, and they are thus more likely to choose a coping strategy than a flight strategy in response to threat. Conversely, we suggest that residents of nations with high average income are more capable of relocating and joining a new group, and thus they are more likely to choose a flight strategy. It is therefore possible that leaders of wealthy groups in extreme climates must offer a better bargain, using less violence and monopolizing fewer vital resources (i.e., conceding more freedom) than those in undemanding climates to prevent their subordinates leaving in search of better weather. Because moderate climates are more comfortable, wealthy citizens there cannot threaten to leave as credibly as can wealthy citizens of extreme climates, so leaders can exploit the former more.

Thus far we have explained how the psychology of threat and bargaining may help explain the observed relationship between climate, average income, and several freedom outcomes. We now offer two cautions. First, harsh climates are one of many kinds of survival threats. Models for predicting freedoms as a function of threat may be improved by considering different kinds of survival threats such as pathogens and parasites, predation, individual/coalitional violence, and resource scarcity. Further, threats to "higher" needs than survival, such as the need for status, may also explain freedom-relevant outcomes. For example, the most variable portion of homicide rates across groups is the rate at which young men kill other young men over status disputes (Daly & Wilson 1988). Models predicting freedom from fear may therefore be improved by including predictors of threats to status.

Our second caution emphasizes the importance of a specific predictor of status threat: income equality. Increasing inequality is a threat to status because it creates a larger gap between

current and desired state, which in turn motivates more extreme efforts to make up the difference (Mishra & Lalumière 2010). A large body of evidence has shown that income inequality, above and beyond average income, predicts a wide array of social, health, and well-being outcomes at the aggregate level, including many directly relevant to freedom (e.g., ingroup vs. outgroup comparisons, competition and discrimination, intergroup violence; reviewed in Wilkinson & Pickett 2009). Furthermore, average income and income inequality are poorly associated at the aggregate level. As a consequence, Van de Vliert's reliance on mean group income to explain outcomes like ethnocentrism and aggression may obscure important effects of within-group income inequality on these outcomes.

Personality traits, national character stereotypes, and climate–economic conditions

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Abstract: Cross-cultural personality research suggests that individuals from wealthier countries tend to be more open-minded. This openness to values may support more democratic governments and the expansion of fundamental freedoms. The link between wealth and freedom is evident in cold-to-temperate climates, but not across wealthy nations in hot climates. Furthermore, temperature and economic conditions shape perceptions of national character stereotypes.

We agree with the basic tenets of Van de Vliert's argument that economic and climatic conditions of a country are closely linked to the levels of fundamental freedoms. In "climate–economic explanation of freedoms," Van de Vliert argues that, depending on climatic conditions, greater economic resources should increase open-mindedness and risk-seeking. He seems to imply that these dispositions favor free choices and the development of more egalitarian societies. This hypothesis has some support in cross-cultural research on personality traits (McCrae et al. 2005). In 51 cultures from around the world, we obtained observer ratings of 12,156 individuals, and we found that individuals from wealthier countries are significantly more likely to be rated as more open to experience. Indeed, the correlation between the average openness from each country and the gross domestic product (GDP) per capita was $r = .47$, $n = 51$. The association was even stronger between GDP and openness to values ($r = .65$, $n = 51$), a facet that measures tolerance and openness to different social, religious, and political values (Costa & McCrae 1992). In turn, cultures with more open-minded individuals tend to be less conservative ($r = -.70$, $n = 22$) (Schwartz 1994), even after accounting for GDP. Cultures with high openness to values have also more democratic regimes ($r = .65$, $n = 49$; Unified democracy score) (Pemstein et al. 2010), even after accounting for GDP. Within the United States, states with higher openness are more likely to endorse liberal values, such as legalization of marijuana and same-sex marriage (Rentfrow et al. 2008). At both individual and culture levels, openness is also associated with lower discrimination, as is the case for HIV (McCrae et al. 2007a).

We found mixed evidence regarding the hypothesis that individuals in wealthier countries are more willing to take risk. Although individuals in high GDP countries were rated as less cautious (deliberation: $r = -.44$, $n = 51$) and more impulsive (impulsiveness: $r = .35$, $n = 51$), GDP was unrelated to

excitement-seeking and was positively associated with self-discipline ($r = .29$, $n = 51$). Furthermore, we found no support for the hypothesis that climatic demands (Van de Vliert 2009) or average temperature contribute to the prediction of openness or risk-taking traits. In a hierarchical regression with GDP in a first step, there was no significant contribution of climatic demands or the interaction of economic resources with climatic demands on openness or risk-taking traits ($p > .05$).

Although we found little support for climate effects on individuals' personality traits, we have found that temperature has a profound effect on the perceptions of groups, or national character stereotypes (Terracciano et al. 2005). Indeed, we found that those living in warmer climates were perceived as interpersonally warmer ($r = .54$, $n = 49$), and temperature was associated with other aspects of national character stereotypes even after accounting for GDP (McCrae et al. 2007b). Especially for cultures from Southern Europe and South America, there seem to be a conflation of hot climate and hot temperament. In many languages, words such as "hot," "warm," and "cold" can be used to describe temperature and temperament, suggesting that the climate-temperament link has deep roots in human cultures. Perceptions of national character were also related to wealth, with those living in rich countries rating the typical member of their country as relatively more conscientious ($r = .44$), less interpersonally warm ($r = -.60$), and with more business-like traits, even after accounting for temperature. Consistent with this pattern, raters from poorer countries (e.g., Nigeria and Indonesia as compared to Germany and the United Kingdom) tend to perceive Americans as more competent (Chan et al. 2011; Terracciano & McCrae 2007). These national character stereotypes do not reflect the actual average traits of these groups (Terracciano et al. 2005), but they seem to shape a national identity that reflects economic strengths and helps distinguish a country from its neighbors. Thus, whether evaluating ingroup or outgroup members, there is a general tendency to attribute traits to groups based on climate-economic conditions, which has some commonality with Van de Vliert's theory.

As noted above, we found little evidence for an interaction between economic and climatic conditions in predicting personality traits (or national character stereotypes). Overall, the evidence for a climate-economic interaction seems weak, particularly the idea that people from wealthy countries in hot climates enjoy high levels of freedoms. Arab states (Saudi Arabia, Qatar, Oman, Bahrain, Kuwait, and United Arab Emirates) and Singapore have high standards of living (e.g., low infant mortality). These wealthy countries in hot climates, however, score low on indices of democracy (Pemstein et al. 2010) and have limited freedoms of expression, press, and religion. In these countries, discrimination based on sex, sexual orientation, and ethnicity is not uncommon. Much greater freedom can be found in wealthy countries with more temperate and colder climates. Van de Vliert's (2009) summer climate index seems also problematic: summer harshness is rated for Russia at 30 as for Nigeria, Bahrain, Iraq, and Kuwait; Canada at 27 as for Bangladesh and Brazil; and Estonia and Finland at 26 as for Ghana and Indonesia. Although climatic demand measures that improve over the average temperature would be desirable, the above examples call into question the face validity of Van de Vliert's (2009) summer index. Finally, some of the evidence in support for a role of climatic demands on discrimination is ambiguous. Indeed, the collectivism index (Vandello & Cohen 1999) used for the 50 United States seems a poor proxy for discrimination and oppression of fundamental freedoms. According to Van de Vliert's reasoning, states such as Hawaii, Maryland, and California rank among the worst in fundamental freedoms along with states such as Louisiana, South Carolina, Mississippi, and Utah. These states differ drastically in political orientation, tax and economic policy, gun control, death penalty, same-sex marriage, and abortion rights. Furthermore, whether these 7 states have worse fundamental freedoms compared to the other 43 states is debatable. In particular, Maryland was the first state with a majority of voters

supporting same-sex marriage and the “Dream Act” granting resident tuition status to undocumented immigrants, two laws aimed at reducing discrimination.

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Subtle variation in ambient room temperature influences the expression of social cognition

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Abstract: Social signaling models predict that subtle variation in climatic temperature induces systematic changes in expressed cognition. An experiment showed that perceived room temperature was associated with variability in self-descriptions, social reactions of others, and desiring differing types of social networks. The findings reflect the tendency to inflate capacity demonstrations in warmer climates as a result of the social networking opportunities they enable.

Van de Vliert’s ecological demands model makes a fresh contribution to the extant literature on climatic conditions and human behavior (Anderson 2001; Cohn 1993; Hancock 1986; Larrick et al. 2011; Zhong & Leonardelli 2008). We agree with Van de Vliert that social cognition is inherently influenced by climatic conditions and individual resource potential, but his model may be complicated by the fact that his key concepts, including human “needs,” “stresses,” and “freedoms” are cognitively defined. These constructs are only measurable through overt behaviors, they lack biological (e.g., phylogenetic) underpinnings, and they are atheoretical. We suggest that his omnibus findings can instead be explained as a much more basic and parsimonious extension of a social signaling model, the Socio-Relational Framework of Expressive Behaviors (SRFB; Vigil 2009). This framework predicts that personal capital and climatic setting each contribute to the types of social networking conditions that facilitate advertisements of either empowerment cues such as the case of expressing human freedom, or advertisements of vulnerability cues in the case of expressing repression-compliance. Temperature variation should therefore induce systematic changes in expressed cognition, including self-descriptions, distress behaviors, and motivations to invest in different types of relationships, irrespective of “cultural management of ambiguity” and similarly vague cognitive concepts. We examined these hypotheses using an experimental protocol and showed that even subtle variability in ambient room temperature influences how people describe their thoughts and feelings.

The SRFB subsumes the following premises: (1) that social signaling (communicative) systems underlie social cognition; (2) that expressive behaviors are composed of “capacity cues” (e.g., empowerment gestures that convey “dominance”) and “trustworthiness cues” (e.g., vulnerability gestures that convey “submissiveness”); (3) that changes in resource acquisition precipitate these gestures; (4) that capacity cues (e.g., expressed confidence) are expressed in conjunction with and used to attract novel relationship partners and maintain larger social networks, and trustworthiness cues (e.g., expressed vulnerability) are used to maintain fewer, more consolidated networks; (5) that climatic conditions influence the size of

individuals’ social networks by either restricting or facilitating interactions with more people; and (6) that climatic conditions prime the expression of trustworthiness-demonstrating dimensions of social cognition in colder climates, and the expression of capacity-demonstrating dimensions in warmer climates.

Social cognition is only measurable via expressive behaviors in the form of verbal and nonverbal gestures (see Ambady & Rosenthal 1992), and Van de Vliert’s representations of freedom can also be interpreted as demonstrations of capacity cues (e.g., signaling confidence and independence). Because climatic conditions affect the ability to acquire resources (e.g., networking opportunities) and influence the ability to aggrandize one’s social network, climatic conditions alone should predict individual differences in the expression of basic capacity displays. As shown in Figure 1, climatic conditions are predicted to covary with networking potential and the expression of trustworthiness and capacity demonstrations of social cognition. Colder climates are comprised of conditions (e.g., snow and darkness) that physically restrict the ability to interact with more affiliates and should therefore covary with heightened expression of trustworthiness cues (e.g., modest and co-dependent self-descriptions) and the motivation to form fewer, more intimate peer networks. Warmer ambient temperatures are instead predicted to result in heightened capacity demonstrations (e.g., inflated and independent self-descriptions) and the motivation to form larger peer networks.

We tested these hypotheses by exposing adults ($n = 202$, 25% male, mean age = 23.7) to ambient room temperatures that only varied between 68°F and 77°F. Using Blind Quantitative Likert (BQL) scales, which electronically record participant responses between two polar anchors via a 100-point interval scale that is concealed to the participants, we examined subtle differences in perceptions of ambient temperature, self-descriptions, distress reactions, and social motivations. Capacity cues were comprised of two items that consisted of self-rated attractiveness (relative to peers) as a job applicant and financial potential ($\alpha = .42$); trustworthiness cues were comprised of three items that measured self-described selfishness (reverse scored), kindness, and responsibility, relative to peers ($\alpha = .43$). Desired social responses from others in times of stress were measured with two items: when feeling *angry* and when feeling *frustrated*, *would you rather be comforted* (a trustworthiness gesture) or *be left alone* (a capacity gesture, $\alpha = .22$). An item also asked about one’s preferred social network (quality and quantity) along a continuum ranging from *having few friends with a large amount of intimacy* to *having a large number of friends with a small amount of intimacy*. Lastly, participants provided an estimate of the room temperature (from 50°F–90°F). These reports were correlated with the actual room temperatures ($r = .34$, $p < .01$) and were used as the main predictor variable.

Perceived room temperature was positively correlated with the omnibus capacity variable ($r = .18$, $p = .01$), negatively correlated with the omnibus trustworthiness variable ($r = -.24$, $p < .01$), and positively correlated with desiring more independence (rather than comfort) from others when experiencing distressful emotions ($r = .14$, $p = .04$). Examination of participants’ subjective social preferences showed that higher perceived temperature was also associated with a greater desire to form larger, less intimate social networks ($r = .14$, $p = .04$).

These findings suggest that even slight variations in ambient room temperature are associated with variability in the expression of social cognition, which we argue can be explained by the social psychological adaptation to express heightened displays of capacity gestures in warmer climates as a result of the social networking opportunities that warmer temperatures enable (Vigil 2009). In theory, this model should incorporate self-reported endorsements of human “freedoms,” because they are associated with specific trait impressions of confidence and independence that signal the impression of dominance and ultimately capacity cues to others. This model is more parsimonious than the cognitive demands model, because the cognitive constructs at the core of the demands model (i.e., human needs and freedoms)

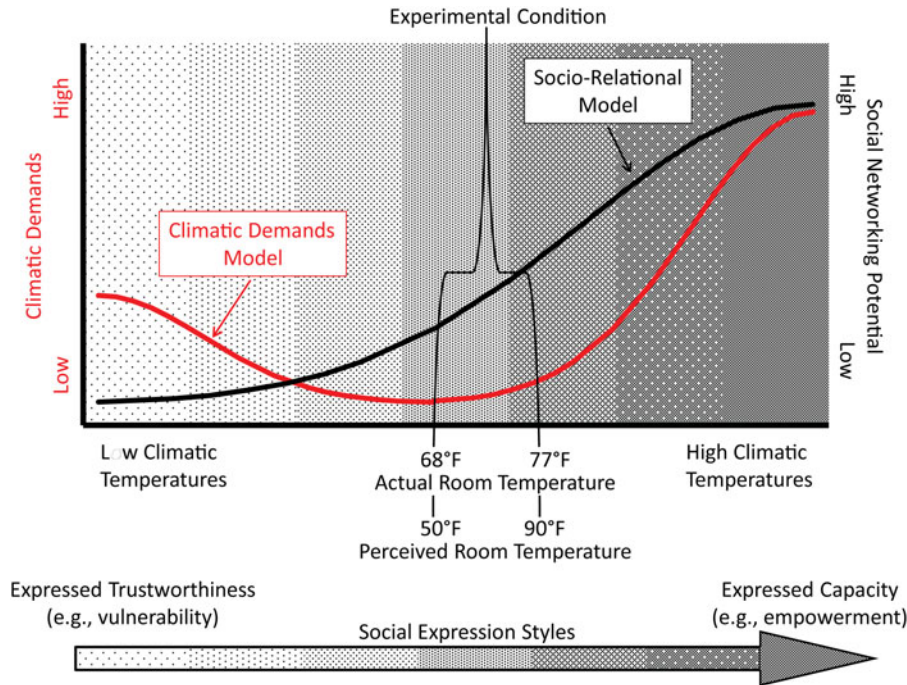


Figure 1 (Vigil et al.). Socio-relational framework of climatic variation, social networking potential, and the expression of capacity and trustworthiness cues.

are only measurable through expressive gestures, and because at a social-signaling level of analysis, even ambiguously defined cognitive constructs can still be systematically interpreted.

Author's Response

White, gray, and black domains of cultural adaptations to climato-economic conditions

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Abstract: Forty-nine commentators have reviewed the theory that needs-based stresses and freedoms are shaped differently in threatening, comforting, and challenging climato-economic habitats. Their commentaries cover the white domain, where the theory does apply (e.g., happiness, collectivism, and democracy), the gray domain, where it may or may not apply (e.g., personality traits and creativity), and the black domain, where it does not apply (e.g., human intelligence and gendered culture). This response article provides clarifications, recommendations, and expectations.

R1. Introduction

When ancient Greeks got a new scientific insight, they visited the *Agora* to discuss their idea with other thinkers.

As our twenty-first-century *Agora* with statements, comments, and responses, *Behavioral and Brain Sciences* serves essentially the same function. I feel fortunate and encouraged now that 49 scholars from wide-ranging disciplines are so actively and interestedly participating in the debate concerning climato-economic conditions under which fundamental human needs are being transformed into culture.

Let me structure our discussion using a plausible point of departure. In common with all theories and methodologies, the climato-economic paradigm has a white domain, where it does apply, a gray domain, where it may or may not apply, and a black domain, where it does not apply at all. This outline of the scientific landscape offers a crude ordering of topics as belonging to white (R2), gray (R3), or black (R4) areas of discussion. The commentators pay considerably more attention to the limited areas of applicability of the theory than to the seemingly endless areas where climato-economic thinking has little or no value attached to it, resulting in an overrepresentation of white topics.

R2. White domain

R2.1. Moving beyond climatic determinism

Allik & Realo reproach me for drawing a deterministic picture in which almost everything in human nature and society is explained by the impact of cold winters and hot summers. This criticism is far from the truth for three reasons. First, after starting with traditional research into main effects of climate on culture (Van de Vliert & Van Yperen 1996; Van de Vliert et al. 1999; 2000), I have consistently rejected single-factor explanations of human functioning, including climatic determinism (e.g., target article,

sects. 4.4 and 6.1). Second, as enunciated in sections 2.2 and 4.6, my central axiom is that climatic demands cannot meaningfully predict variation in shared culture as long as income conditions are left out of consideration. Third and foremost, extensive testing of the moderating effect of money perhaps represents the most systemic attack on climatic determinism ever since the ancient Greeks started to discuss the climate-culture conundrum.

For more than twenty-five centuries, climatic determinism has been mostly characterized by main effects of annual mean temperature on psychobehavioral functioning, main effects that are not expected to be altered by nonthermal conditions. Essentially in the same vein, **Allik & Realo** are of the opinion that the target article should have paid more attention to unqualified main effects of annual mean temperature on national character stereotypes (e.g., McCrae et al. 2007; Pennebaker et al. 1996; Terracciano et al. 2005), personality traits (e.g., Allik & McCrae 2004), and individual intelligence (e.g., Lynn & Vanhanen 2006). My single most important reason for trying to get away from those and similar attempts to exclusively tie climate to personality is to move beyond the myopic single-factor explanation offered by climatic determinism.

R2.2. Demands: Cold climate versus hot climate

Climates are considered more demanding to the extent that their winters are colder than 22°C and their summers are hotter than 22°C. **Chang, Chen, & Lu (Chang et al.)** find this an inaccurate operationalization as ancestral living conditions in Africa suggest that cold climates are more demanding than hot climates, not least because flora and fauna resources increase in hotter climates. In contrast with this argument, most plants and creatures, notably including humans and parasites, are spontaneously moving away from not only arctics but also deserts. The bottom line is that all living species on earth can easily be either frozen or burned to death. In consequence, only a bipolar measure of climatic demands can capture the fundamental fact that extreme cold and extreme heat both pose existential problems for humans.

Self-evidently, the bipolar structure of colder-than-temperate and hotter-than-temperate climates is not necessarily a symmetrical structure. On the contrary, it is unlikely that climatic demands, measured in degrees Celsius as absolute deviations from 22°C, are approximately the same on the cold side and the hot side. **De Oliveira Chen & Kitayama** rightly observe that winters on this planet are generally more problematic than summers. Winter demands range from an absolute deviation of 1 on the Marshall Islands to a relatively high peak of 87 in Mongolia, whereas summer demands range from 2 in Colombia to a relatively low peak of 44 in Sudan (Van de Vliert 2009). The smaller range of summer demands is caused by more direct and more concentrated sun rays, as well as by more sun exposure because of longer daylight hours. As one notable consequence, in the hottest summer month, high-latitude Mongolians and low-latitude Sudanese have to cope with very different lowest temperatures (−6°C and 40°C, respectively) but very similar highest temperatures (36°C and 48°C, respectively).

The restriction of range in summer demands leads **Terracciano & Wayne** to call into question the face validity of the summer part of the climate index used in the target

article. They appear to put their finger on the problem that some populations are coping with cold demands in summer (e.g., Estonians, Finns, Mongolians, North Koreans, and Russians). To be sure, this does not influence any of the results reported in the target article, which are based on summed total demands. But further research on the differential effects of cold and heat should use indices for cold demands ($r = .99$ with winter demands) and heat demands ($r = .76$ with summer demands). To this end, **Table R1** lists cold demands, heat demands, and total climatic demands for 232 independent countries and dependent territories around the planet.

Murray approaches the cold-hot asymmetry from yet another angle. Threats posed by hot climates, so his argument runs, are mediated by higher prevalence of infectious diseases, whereas cold climates pose more direct threats to survival. This is an intriguing and easily testable hypothesis. In a stepwise regression analysis, I used parasitic disease burden (source: Fincher & Thornhill 2012), heat and cold demands from **Table R1**, and monetary resources from section 3.3 as standardized predictors of the freedom index for 2012 set forth in Electronic Supplement 4.B. Across 104 countries, Model 1 in **Table R2** replicates the well-documented negative impact of the prevalence of non-zoonotic diseases on overall freedom (Fincher & Thornhill 2012; Van de Vliert & Postmes 2012). The next steps show that parasitic disease burden ($bs \leq -.11, ps \geq .07$) does not mediate the link between heat demands and repression of freedom (Model 2), especially not in continental climates where heat demands reinforce cold demands (Model 3).

Models 4 through 6 further reveal that parasitic disease burden does neither mediate the main effect nor the interactive effects of monetary resources. In addition to the direct explanatory path from heat demands to overall freedom, increases in monetary resources are accompanied by greater freedom (Model 4), especially in populations coping with colder winters (Model 5). The visualization of Model 6 in **Figure R1** may be compared with **Figure 2** in the target article. This comparison uncovers that the present results supplement the target article by showing that the theory predicts freedom better in habitats with low heat demands (left picture) than in habitats with high heat demands (right picture).

Within **Figure R1**, the contrast between the upper slope at the left ($b = .51, p < .01$) and the upper slope at the right ($b = .09, p = .77$) suggests that richer countries make the difference. For richer populations, it seems easier to achieve freedom in habitats where cooler summers make colder winters more challenging (left picture: low heat, high cold) than in habitats where hotter summers make colder winters more threatening (right picture: high heat, high cold). This finding is compatible with climato-economic theorizing because continental climates with hot summers and cold winters are generally more demanding than climates with at least one temperate season. It is very well thinkable that those really harsh climates reach the point where even richer populations appraise their habitats as more threatening than challenging and start to voluntarily curtail their freedom.

Recall from Electronic Supplement 3 that overall freedom in 2012 is a common denominator that is closely related with its components of freedom from press repression ($r = .94$), freedom from positive ingroup discrimination ($r = .83$), and freedom from political autocracy ($r = .95$).

Table R1. *Cold demands, heat demands, and total climatic demands for 232 independent countries and dependent territories, followed by computational notes^{a, b, c} and examples^{c1, c2, c3}.*

Country or territory	Climatic demands		
	Cold ^a	Heat ^b	Total ^c
Afghanistan	62	18	80
Albania	44	18	62
Algeria	33	22	55
Andorra	66	14	80
Angola	9	21	30
Antigua and Barbuda	8	25	33
Argentina	44	21	65
Armenia	71	18	89
Aruba	5	23	28
Australia	55	21	76
Austria	67	16	83
Azerbaijan	71	18	89
Bahamas	20	19	39
Bahrain	17	32	49
Bangladesh	15	29	44
Barbados	7	20	27
Belarus	91	10	101
Belgium	64	15	79
Belize	17	24	41
Benin	4	22	26
Bermuda	23	20	43
Bhutan	28	16	44
Bolivia	46	5	51
Bosnia and Herzegovina	61	19	80
Botswana	38	29	67
Brazil	16	27	43
Brunei	6	18	24
Bulgaria	63	15	78
Burkina Faso	16	42	58
Burma (Myanmar)	9	31	40
Burundi	7	15	22
Cambodia	8	31	39
Cameroon	13	23	36
Canada	88	17	105
Cape Verde	9	20	29
Cayman Islands	10	25	35
Central African Republic	12	28	40
Chad	17	38	55
Chile	42	20	62
China	61	21	82
Christmas Island	4	25	29
Cocos Island	6	22	28
Colombia	33	2	35
Comoros	3	19	22
Congo-Brazzaville	13	25	38
Congo-Kinshasa	11	24	35
Cook Island	6	22	28
Costa Rica	21	18	39
Côte d'Ivoire	9	23	32
Croatia	63	20	83
Cuba	14	24	38
Cyprus	35	22	57
Czech Republic	75	16	91

(continues)

Table R1 (Continued)

Country or territory	Climatic demands		
	Cold ^a	Heat ^b	Total ^c
Denmark	72	11	83
Djibouti	5	38	43
Dominica	8	26	34
Dominican Republic	9	26	35
Ecuador	40	12	52
Egypt	26	34	60
El Salvador	21	34	55
Equatorial Guinea	8	17	25
Eritrea	5	34	39
Estonia	87	11	98
Ethiopia	37	17	54
Falkland Islands	68	2	70
Faroe Islands	61	0	61
Fiji	12	25	37
Finland	87	11	98
France	57	18	75
French Guiana	5	25	30
French Polynesia	6	22	28
Gabon	8	26	34
Gambia	16	30	46
Gaza Strip	36	23	59
Georgia	47	18	65
Germany	68	16	84
Ghana	8	26	34
Gibraltar	29	17	46
Greece	35	21	56
Greenland	86	2	88
Grenada	9	23	32
Guadeloupe	15	18	33
Guam	3	17	20
Guatemala	27	16	43
Guernsey	55	12	67
Guinea	6	23	29
Guinea-Bissau	10	34	44
Guyana	2	21	23
Haiti	8	28	36
Honduras	12	11	23
Hong Kong	22	18	40
Hungary	67	17	84
Iceland	72	1	73
India	23	30	53
Indonesia	4	26	30
Iran	54	21	75
Iraq	34	30	64
Ireland	61	8	69
Isle of Man	55	12	67
Israel	36	23	59
Italy	41	18	59
Jamaica	10	25	35
Japan	36	16	52
Jersey	55	12	67
Jordan	37	23	60
Kazakhstan	84	20	104
Kenya	28	13	41
Kiribati	4	25	29

(continues)

Table R1 (Continued)

Country or territory	Climatic demands		
	Cold ^a	Heat ^b	Total ^c
Kuwait	21	34	55
Kyrgyzstan	81	16	97
Laos	19	29	48
Latvia	87	11	98
Lebanon	27	23	50
Lesotho	47	17	64
Liberia	11	19	30
Libya	26	30	56
Liechtenstein	67	16	83
Lithuania	87	11	98
Luxembourg	70	15	85
Macau	22	18	40
Macedonia	61	19	80
Madagascar	31	18	49
Malawi	32	18	50
Malaysia	5	28	33
Maldives	5	25	30
Mali	17	39	56
Malta	21	18	39
Marshall Islands	0	24	24
Martinique	9	22	31
Mauritania	15	38	53
Mauritius	16	18	34
Mayotte	3	19	22
Mexico	38	11	49
Micronesia	0	24	24
Moldova	74	13	87
Monaco	34	12	46
Mongolia	115	14	129
Montenegro	63	20	83
Montserrat	8	25	33
Morocco	32	31	63
Mozambique	20	36	56
Namibia	39	17	56
Nauru	4	25	29
Nepal	28	16	44
Netherlands	65	12	77
Netherlands Antilles	5	23	28
New Caledonia	15	22	37
New Zealand	44	9	53
Nicaragua	2	22	24
Niger	17	40	57
Nigeria	7	30	37
Niue	6	22	28
North Korea	62	7	69
Northern Mariana Islands	3	17	20
Norway	77	12	89
Oman	11	38	49
Pacific Islands Trust	0	24	24
Pakistan	31	28	59
Palau	6	27	33
Panama	6	26	32
Papua New Guinea	5	25	30
Paraguay	34	36	70
Peru	19	16	35

(continues)

Table R1 (Continued)

Country or territory	Climatic demands		
	Cold ^a	Heat ^b	Total ^c
Philippines	8	28	36
Pitcairn Islands	6	22	28
Poland	77	13	90
Portugal	33	18	51
Puerto Rico	6	21	27
Qatar	19	34	53
Reunion	16	18	34
Romania	74	19	93
Russia	91	10	101
Rwanda	18	7	25
Saint Helena	11	16	27
Saint Kitts and Nevis	8	25	33
Saint Lucia	9	23	32
Saint Pierre and Miquelon	61	8	69
Saint Vincent and the Grenadines	9	23	32
Samoa	6	22	28
San Marino	41	18	59
São Tomé and Príncipe	11	20	31
Saudi Arabia	32	31	63
Senegal	11	34	45
Serbia	63	20	83
Seychelles	3	19	22
Sierra Leone	4	22	26
Singapore	4	25	29
Slovakia	79	17	96
Slovenia	63	20	83
Solomon Islands	4	25	29
Somalia	8	22	30
South Africa	39	24	63
South Korea	64	15	79
Spain	52	17	69
Sri Lanka	7	23	30
Sudan	20	44	64
Suriname	8	26	34
Swaziland	40	20	60
Sweden	76	13	89
Switzerland	67	16	83
Syria	38	23	61
Taiwan	25	24	49
Tajikistan	66	19	85
Tanzania	20	23	43
Thailand	11	34	45
Timor-Leste	4	26	30
Togo	8	26	34
Tokelau	4	25	29
Tonga	6	22	28
Trinidad and Tobago	17	29	46
Tunisia	34	29	63
Turkey	69	16	85
Turkmenistan	53	20	73
Turks and Caicos	20	19	39
Tuvalu	4	25	29
Uganda	17	21	38
Ukraine	74	13	87

(continues)

Table R1 (Continued)

Country or territory	Climatic demands		
	Cold ^a	Heat ^b	Total ^c
United Arab Emirates	19	34	53
United Kingdom	55	12	67
United States	59	20	79
Uruguay	40	25	65
Uzbekistan	53	20	73
Vanuatu	12	25	37
Venezuela	25	17	42
Vietnam	16	32	48
Virgin Islands	8	25	33
Wallis and Futuna	6	22	28
West Bank	36	23	59
Western Sahara	33	32	65
Yemen	3	30	33
Zambia	26	22	48
Zimbabwe	35	17	52

^a Cold demands are the sum of the absolute downward deviations from 22°C for the average lowest temperature in the coldest month, the average highest temperature in the coldest month, the average lowest temperature in the hottest month, and the average highest temperature in the hottest month.

^b Heat demands are the sum of the absolute upward deviations from 22°C for the average lowest temperature in the coldest month, the average highest temperature in the coldest month, the average lowest temperature in the hottest month, and the average highest temperature in the hottest month.

^c Total climatic demands is the sum of cold demands and heat demands. Three prototypical examples of computations follow.

^{c1} The most extreme case on the cold side: In Mongolia, the lowest and highest temperatures in the coldest month are -44°C and 1°C; the lowest and highest temperatures in the hottest month are -6°C and 36°C. The climatic demands are $| -44^{\circ}\text{C} - 22^{\circ}\text{C} | + | 1^{\circ}\text{C} - 22^{\circ}\text{C} | + | -6^{\circ}\text{C} - 22^{\circ}\text{C} | + | 36^{\circ}\text{C} - 22^{\circ}\text{C} | = 129$.

^{c2} A prototypical case on the temperate side: In Burundi, the lowest and highest temperatures in the coldest month are 17°C and 20°C; the lowest and highest temperatures in the hottest month are 28°C and 31°C. The climatic demands are $| 17^{\circ}\text{C} - 22^{\circ}\text{C} | + | 20^{\circ}\text{C} - 22^{\circ}\text{C} | + | 28^{\circ}\text{C} - 22^{\circ}\text{C} | + | 31^{\circ}\text{C} - 22^{\circ}\text{C} | = 22$.

^{c3} The most extreme case on the hot side: In Sudan, the lowest and highest temperatures in the coldest month are 5°C and 19°C; the lowest and highest temperatures in the hottest month are 40°C and 48°C. The climatic demands are $| 5^{\circ}\text{C} - 22^{\circ}\text{C} | + | 19^{\circ}\text{C} - 22^{\circ}\text{C} | + | 40^{\circ}\text{C} - 22^{\circ}\text{C} | + | 48^{\circ}\text{C} - 22^{\circ}\text{C} | = 64$.

As a logical consequence, and contradicting Murray, who predicts otherwise, the results reported in Table R2 and Figure R1 are almost equally applicable to freedom from press repression, ingroup discrimination, and political autocracy. Apparently, the differential effects of climatic cold and heat affect the three distinct components of overall freedom similarly rather than differently.

R2.3. Resources: Possible roles of money

Six commentators profess that climate helps generate both economic development and cultural change, although Ainslie and Chang et al. think that wealth precedes culture whereas de Oliveira Chen & Kitayama think that culture precedes wealth. Both beliefs seem to ignore that climatic demands do not plausibly account for

income per head, neither in their main effects (sect. 3.3), nor in their interaction effects with geographic resources (Electronic Supplement 5.A), land and marine resources (Electronic Supplement 5.B), and natural security resources (Electronic Supplement 5.C). Perhaps even more important, both beliefs are blind to the fact that it is a strength rather than a weakness that the climato-economic theory of culture parsimoniously and accurately explains how climatic demands and monetary resources interact to create culture (white domain) and does not sidetrack into main effects of climatic demands on monetary resources (black domain).

Notwithstanding this advance in establishing theoretical boundaries, Fischer makes it clear that the monetary part of the theory is still in its infancy. He asks pertinent questions about the specific cultural impacts of collective versus individual income, absolute versus relative income, and alternative investments of these incomes in health and child care versus educational resources. By contrast, progress has been made on Iyer, Motyl, & Graham's (Iyer et al.) dilemmatic question of whether wealth or freedom comes first. Given that climate does come first, it is a telling finding that climatic demands do interact with national wealth in predicting freedom but do not or hardly interact with freedom in predicting national wealth (Electronic Supplement 5.D; Van de Vliert 2007; 2009; 2011b). This consistent finding supports the economy-drives-culture camp (e.g., Bell 1973; Inglehart & Welzel 2005; Marx 1973; Sen 1999) in the continuing debates with the culture-drives-economy camp (e.g., Fukuyama 1995; Harrison & Huntington 2000; Weber 1904/1958).

R2.4. Needs as origins of culture

According to Locke & Flanagan, the target article over-emphasizes environmental causes while underemphasizing the active operation of psychological needs as origins of culture. They gain support from Pahlavan & Amirrezvani, who contend that the climato-economic contextualization completely overshadows the social-psychological contextualization of freedom. Unfortunately, these are misrepresentations of the theory. In fact, climatic demands and monetary resources are seen as inanimate contexts; only real people can bring them to life through meaning, emotion, and movement. Climato-economic environments as passive conditional origins cannot replace fundamental needs as active ultimate origins of culture. In agreement with Locke & Flanagan, the target article proposes that existence needs, social needs, and growth needs are continuously accessible and waiting for activation by exogenous cues. The main idea, introduced up front in section 1, is that needs shape stresses and choices, but do so differently within concentric contexts of the immediate social-psychological setting and the remote habitational environment.

There may, of course, be several causal steps in between contextualized needs and ultimate adaptations. If one link in the chain is missing, anthropologists such as Hrotic, often coping with fragmentary evidence, "do not necessarily discard everything that follows" (in Hrotic's words, para. 2). Sociologists and psychologists tend to be more reluctant to theoretically jump across a gap between a before and an after. One causal path is that contextualized needs shape societal institutions, values, and practices, which in turn shape individual inhabitants (as Güss

Table R2. Joint effects of parasitic disease burden, heat demands, cold demands, and monetary resources on overall freedom^a (n=104 countries; see footnotes for measures used)

Regression Model	1	2	3	4	5	6
Unstandardized Coefficient	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
Constant	.17	.05	-.19	-.20	-.29**	-.27**
Parasitic Disease Burden ^b	-.20***	-.09	-.11	.04	.04	.04
Heat Demands (HD) ^c		-.22*	-.36***	-.24**	-.25**	-.23*
Cold Demands (CD) ^d		.18	-.09	-.09	.01	-.00
HD × CD			-.57***	-.50***	-.13	-.11
Monetary Resources (MR) ^e				.53***	.44***	.40***
HD × MR					-.13	-.16
CD × MR					.36***	.30**
HD × CD × MR						-.10
ΔR^2	.18***	.07**	.11***	.16***	.10***	.00
R^2	.18***	.25***	.36***	.52***	.62***	.62***

^a $p < .05$, ^{**} $p < .01$, ^{***} $p < .001$. There was no multicollinearity ($VIFs < 4.17$), and there were no outliers (Cook's $Ds < .28$).
^a Overall freedom is the standardized average of freedom from press repression, from positive ingroup discrimination, and from political autocracy. Detailed information about the construction of this index for freedom in 2012 is provided in section 5.2.1 of the target article and in Electronic Supplement 4.B.
^b Parasitic disease burden is the prevalence of human-to-human transmitted nonzoonotic diseases (source: Fincher & Thornhill 2012).
^c HD=Heat demands taken from Table R1.
^d CD=Cold demands taken from Table R1.
^e MR=Income per head as described in section 3.3 of the target article.

would have it), but it is no less possible that contextualized needs shape individuals, which in turn shape societal cultures (as Baumeister, Park, & Ainsworth [Baumeister et al.], Fischer, and Loughnan, Bratanova, & Kuppens [Loughnan et al.] would have it). To complicate matters further, the causal path is not likely the same for each freedom predicted. Allik & Realo and Fischer convincingly argue that the commonality of the fundamental freedoms is too weak to treat them holistically and that specification of the mediating variables could increase

explanatory strength. Similarly, Iyer et al. point to the heterogeneity and mutual incompatibility of freedoms ranging from gaining something to not losing something, which makes a catch-all explanation inaccurate at best and impossible at worst.

By stressing the importance of contextualized needs as origins of culture, climato-economic theorizing sheds new light also on processes of globalization brought up by Pahlavan & Amirrezvani. Globalization as the evolvment of a syndrome of universally endorsed values, beliefs, and

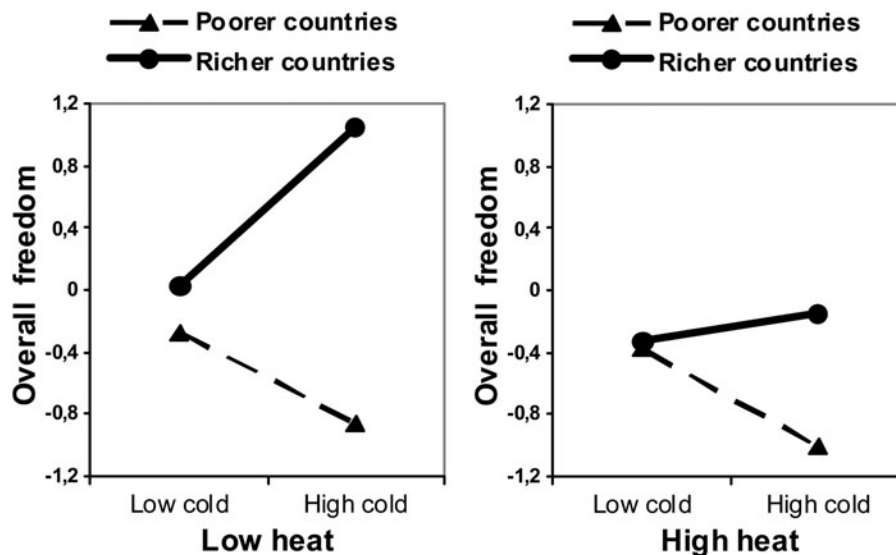


Figure R1. Joint effects of heat demands, cold demands, and monetary resources on overall freedom while controlling for parasitic disease burden.

practices seems to have its limits because climate-based demands and wealth-based resources in concert help shape unique needs-based local cultures (Van de Vliert et al. 2009). Global warming will make many African habitats more threatening, many Asian habitats less threatening, and many European and North American habitats less challenging (sects. 5.3 and 6.3; Electronic Supplement 6). Economic ups and downs will continue to have local winners and losers, most likely with peaking overpayment of poor populations in temperate climates (Van de Vliert 2003). Given these climato-economic dynamics and corresponding changes in needs, globaphobes and globaphiles may have too unrealistic nightmares and daydreams about the sameness of cultures around the globe in times to come.

R2.5. Individual functioning

Fischer suggests extensions of climato-economic theorizing from the population level to the personal level (from *eco-logic* to *psycho-logic* in **Leung & Cheng's** terminology), and substantiates that climatic demands interact with both societal wealth and individual wealth in producing individual happiness. However, results are less convincing for greater personal valuation of protecting freedom of speech and giving people more say in important government decisions, and lesser personal valuation of fighting rising prices and maintaining order in the nation. These so-called post-materialist values (Inglehart et al. 2004, p. 410) are driven more by demanding climates in interaction with societal income rather than individual income. Now taking shape is the sensible hypothesis that household income is more important for family-oriented coping with demanding winters and summers, whereas national income is more important for society-oriented coping with such seasons.

With a view to the assessment of whether people experience their habitats as threatening, comforting, or challenging, **Fischer** makes the mind-broadening observation that shared appraisals of stresses are themselves rooted in physiological and neurocognitive processes worthy of ecological study. Not only do I agree with this recommendation, Reinold Gans, Mike De Jongste, and I (Van de Vliert et al., under review) have recently investigated whether or not inhabitants' blood pressure is higher in habitats with lower climato-economic livability. Across 120 countries, we were able to demonstrate that systolic blood pressures are highest in poor countries with cold winters and hot summers (*too threatening*) and in rich countries with warm winters and cool summers (*too unchallenging*).

R2.6. Collective functioning

Fischer further notices that demands-resources theories at the personal level are used to underpin climato-economic studies at the population level, leaving a conceptual gap between explanations of individual and collective processes. On closer scrutiny, this is an imaginary gap. Bandura (1997) argues at length that greater demands in interaction with sufficient resources to meet the demands increase both self-efficacy at the individual level and collective efficacy at the level of families, institutions, communities, and even nations. Besides, it is a strength rather

than a weakness if one takes hypotheses from the individual realm and confirms them for collectives in order to generalize insights across levels of understanding (Smith 2004; Van de Vliert & Janssen 2002).

Against this background, it is important to note that some anthropological narratives seem to support climato-economic theorizing. Concentrating on the history of religions and the emergence of state-level hierarchies in the ancient Near East, **Hrotic** confirms that inhabitants of threatened habitats evolved autocratic and doctrinal adaptations to survive. During the fourth millennium BCE, poor populations in cooling and drying habitats located alongside main rivers (e.g., Tigris, Nile, and Indus) restrained their freedoms by tightly organizing agricultural labor and centralizing power in the hands of kings and priests. Five millennia later, when the Little Ice Age replaced the Medieval Warm Period, essentially the same adaptational processes of formalization and centralization following climato-economic deterioration seem to have pushed Norse communities in medieval Greenland on a slippery slope toward extinction (Van de Vliert 2013).

Baumeister et al. entertain the notion that even the Renaissance in Europe may be seen as a cultural adaptation of rich societies coping with demanding climates. It may indeed be no coincidence that the Medieval Warm Period was followed by centuries characterized by a challenging palette of global cooling, economic growth, and greater freedom (politically, religiously, scientifically, and artistically), culminating in, for example, the Golden Age of the Netherlands. In the words of Baumeister et al., the sixteenth and seventeenth century saw "the emergence of the individualistic form of selfhood that promotes inner exploration of the single person and allows people to choose and define who they are" (para. 2).

Zooming in on how exactly collectives shape culture, Adamopoulos (1999; 2012) has integrated the social resource theory (Foa & Foa 1974), the taxonomy of sociality (Fiske 1991), and Triandis's (1995) typology of collectivism and individualism. Using exchanges of material resources (money, goods, and services) and symbolic resources (love, status, and information) as integrating tools, **Adamopoulos** has mapped out eight branches of collectivism and individualism. His present commentary adds that freedoms can be understood as involving the acquisition and exchange of the six major classes of material and symbolic resources. As an attractive consequence, climato-economic theorizing might then help explain the eight resource-based branches of collectivism and individualism.

The left arrow in **Figure R2** predicts that authority ranking and branches of vertical collectivism are most prevalent in threatening climato-economic habitats. The right arrow predicts that equality matching and branches of horizontal individualism are most prevalent in challenging climato-economic habitats. The middle arrow is much less accurate in its predictions of culture because no distinction is made yet between poor and rich populations residing in comforting habitats. It is here that **Adamopoulos's** differentiation of culture-common facets of social exchanges exposes ambiguities in the current version of the climato-economic theory of culture. It is here where research could blaze new trails in order to enhance our understanding of collectivism and individualism as cultural adaptations to local environments. For example, one might expect altruistic collectivism to be

Thermal climate	Cold or hot	Temperate	Cold or hot			
Climatic demands	Demanding	Undemanding	Demanding			
Monetary resources	Poor	Poor or rich	Rich			
Cultural adaptations	↓ ↓ ↓					
Habitat appraisal	Threatening	Comforting	Challenging			
Fiske (1992)	Authority ranking	Communal sharing Market pricing	Equality matching			
Triandis (1995)	Vertical collectivism	Vertical individualism Horizontal collectivism	Horizontal individualism			
Adamopoulos (2012)	Relational collectivism	Referential collectivism	Ego-protective Acquisitive	Ideational Altruistic	Egocentric individualism	Ego-sustaining individualism

Figure R2. Collectivist versus individualist adaptations to three types of climato-economic habitats.

common among rich populations in temperate climates where “there is an overabundance of resources and life is viewed as a non-zero-sum game” (Adamopoulos 1999, p. 71).

According to **Karwowski & Lebuda**, creativity can be either threat-based (cf. left arrow in Fig. R2) or challenge-based (cf. right arrow in Fig. R2), but their research leads to a more nuanced picture of collective creative achievements. Relatively uncreative inhabitants of poorer countries tend to be somewhat more creative under harsher climatic conditions. Relatively creative inhabitants of richer countries tend to be most creative under optimal rather than too demanding or too comfortable climatic conditions. These results are difficult to reconcile with the aforementioned peaks of elevated blood pressure. They are reminiscent, though, of effects of colder winters and hotter summers on subjective well-being. In poorer countries, more demanding climates appear to decrease health and happiness. But in richer countries, subjective well-being is optimal if there is one really challenging season: too much stress of cold winters and hot summers, as well as too little stress of warm winters and cool summers, reduce health and happiness (Van de Vliert 2009; Van de Vliert et al. 2004). Is creativity similarly optimal in rich countries with optimal seasonal challenges?

R2.7. Supplementary explanations

It would be rather naïve to claim that climato-economic conditions are the most important, let alone the only, antecedents of culture. This section therefore appreciably

discusses limited growing seasons, frontier migration, political history, income inequality, social capital, and bargaining power as complementary and subsidiary explanations of collective functioning. With regard to limited growing seasons, **Ainslie** highlights the hypothesis that a too cold climate to grow crops for part of the year punishes lack of foresight and rewards intertemporal self-control and preparation – consequences that denizens of warm climates can afford to ignore. This presumption denies that a hot desert climate also is unkind to crops, as is evidenced by the lower agricultural output in both colder-than-temperate and hotter-than-temperate climates (Cline 2007). But even if reasoning is extended to include the motivational and cultural consequences of limited growing seasons in too hot climates, this single-factor explanation still runs the risk of climatic determinism (cf. R2.1).

De Oliveira Chen & Kitayama explore theoretically whether migration to rugged lands of frontier could possibly explain individualist culture better than climato-economic conditions do. Their arguments in favor of that explanation are that (a) Americans and Japanese who historically settled in ecologically harsh, sparsely populated, and socially primitive regions evolved a stronger ethos of independence, and (b) Chinese in provinces with more demanding climates have higher divorce rates. Arguments against the frontier explanation are that it cannot account for why historical migration out of Africa and into more threatening colder regions resulted in (a) individualist Kenyans at low latitudes but collectivist Mongolians at high latitudes (Van de Vliert 2011b), (b) individualist Europeans but collectivist Asians at comparable latitudes, and

(c) more individualist Chinese in provinces with less demanding climates (sect. 4.4.2; Van de Vliert et al. 2013b). Further research should determine whether the frontier-migration explanation can fruitfully supplement or refine the climato-economic explanation of cultural individualism versus collectivism.

Güss has confidence that a country's political history is a more important driver of cultural freedoms than climatic and economic histories are. Calling up the salient transitions from the democratic Weimar Republic through the totalitarian Hitler era to the federal parliamentary republic of Western Germany, Güss makes it clear that climato-economic theorizing provides a partial explanation of cultural freedoms at best. A complicating consideration is that climato-economic habitats covary with both political freedoms (sect. 4.5) and nonpolitical freedoms, including press freedom (sect. 4.2). This poses the following puzzle for future research: Are political freedoms mediating between climato-economic habitats and nonpolitical freedoms? Are nonpolitical freedoms mediating between climato-economic habitats and political freedoms? Or is it better to drop the issue of mediation by viewing all freedoms as distinct yet closely interrelated fruits from the same climato-economic tree (see Electronic Supplement 3)?

Sparks, Mishra, & Barclay (Sparks et al.) caution that income inequality may be a rival predictor of culture. However, a large body of research evidence has established that this is not a very serious danger. Income inequality does not affect or negligibly affects climato-economic imprints on employee harassment (sect. 4.2), press repression (sect. 4.2), survival versus self-expression culture (Van de Vliert 2007), selfish versus cooperative enculturation of children (Van de Vliert et al. 2009), and ingroup favoritism in the form of nepotism (Van de Vliert 2009). Additionally, when the regression analysis from Table R2 was repeated with both parasitic disease burden and income inequality controlled for, income inequality did not reach significance in any of the six regression equations.

Locke & Flanagan build a compelling case for human and social capital as resources that can replace monetary resources to meet fundamental needs. It would make the case even more interesting if they were to make a distinction between ingroup capital and outgroup capital. Collectivists in threatening habitats tend to invest and build social capital in ingroup members at the expense of outgroup members; individualists in challenging habitats tend to invest and build social capital in individual others no matter whether they are members of ingroups or outgroups (sects. 2.4.4 and 4.4). Because every world citizen has a world full of outgroup members and very few ingroup members, individualists seem to be in a much better position to accumulate social capital than collectivists are. Indeed, human capital (sects. 2.4.2 and 4.5) and social capital (sects. 4.4.1 and 4.5) both tend to increase in more challenging habitats. For example, inhabitants of challenging habitats have invested a lot in two of Coleman's (1990) cornerstones of social capital: generalized trust in others (Kong 2013) and cooperative attitudes at work (Van de Vliert 2009).

Rather than thinking in terms of social capital and trust, Sparks et al. believe it makes much difference that inhabitants of more challenging habitats have more means to escape the situation. Poor people in extreme climates have little choice but to bargain in tight hierarchical

groups to meet shared needs. By contrast, rich people in extreme climates have the option of avoiding climatic stress by relocating elsewhere, of bargaining with home groups, host groups, or both. In other words, inhabitants of more challenging habitats have more bargaining power and leeway to create freedom. This will certainly work at the individual level but it remains to be empirically verified whether this is a viable explanation at the level of entire communities as well.

R2.8. Research methods

De Oliveira Chen & Kitayama fear that Huadong Yang, Yongli Wang, Xiao-peng Ren, and I (Van de Vliert et al. 2013b) have made a mistake by comparing incomparable self-report measures of collectivism gathered from inhabitants of 15 Chinese provinces. However, we have tried to minimize that risk in several ways. First, we sampled only Han Chinese in order to standardize ethnicity. Second, we sampled only employees of medium-sized enterprises in smaller towns to also standardize the employment situation. Third, we randomly chose the population of Gansu as a reference group and compared the factor loadings of Gansu with those of the populations in the other provinces. Reflecting factorial similarity and construct equivalence across provinces, Tucker's φ ranged from .85 in Hebei to .97 in Shanxi ($M_\varphi = .91$). Finally, we interpreted it as a sign of comparative construct validity that the positive climate-discrimination link across poor countries also holds across predominantly poor provinces within China.

In striking contrast to the self-report measures of Chinese collectivism, Vandello and Cohen (1999) employed eight unobtrusive estimates of collectivism to study cultural differences within the United States. The target article adopted their collectivism index as a proxy for positive ingroup discrimination, but Terracciano & Wayne doubt whether the unobtrusive state rankings are a valid representation of discrimination between ingroups and outgroups. Vandello and Cohen (1999) had the same concern, reasoned that states with larger numbers of ethnic minorities should be generally more collectivist, and made certain that there is a strong link between percentage of minorities and a state's collectivism score ($r = .75, p < .001$). Conway et al. (2006) later argued that collectivism promotes the adoption of restrictive laws and then showed that legislative restrictions in 50 United States and the District of Columbia are positively associated with Vandello-Cohen collectivism ($r = .47, p < .001$). Both correlations attest to the validity of the collectivism index used.

Loughnan et al. would like to see more multi-level tests of the climato-economic theory, despite the multi-level finding, reported in section 4.4.2, that culture building in climato-economic habitats is a collective rather than an individual process, at least in China today. Earlier in this issue, also using multi-level modeling, Fischer reports that individual inhabitants of challenging climato-economic habitats are happier and place more value on freedom of speech and political participation rather than fighting rising prices and maintaining order in the nation. But more multi-level research would certainly be most welcome, especially to estimate the relative weight of collective and individual pushing and pulling toward shared

needs, stress appraisals, and fundamental freedoms in threatening, comforting, and challenging habitats.

Several commentators (**Arantes, Grace, & Kemp** [Arantes et al.]; **Iyer et al.**; **Leung & Cheng**; **Loughnan et al.**) see merit in using more longitudinal analyses. Arantes et al. specifically encourage a replication study using climatic demands and monetary resources in the past as predictors of freedom at present. Richard Tol and I (Van de Vliert & Tol 2012) have recently done just that. In a 147-nation study, we showed that the initial level of democratic freedom in 1978, climatic demands in 1978, national wealth in 1978, and economic growth between 1979 and 2008 accounted for 49% of the changes in democracy between 1979 and 2008. Increases in democratic freedom were minimal in countries with lower economic development if they were more democratic initially and situated in more demanding climates (e.g., Turkey), and maximal in countries with higher economic development if they were more autocratic initially and situated in more demanding climates (e.g., Poland).

In addition to placing emphasis on longitudinal designs, **Leung & Cheng** put forward a number of intellectually stimulating ideas to further develop climato-economic theory, most notably including the use of cities and families as lower-level units of analysis and the tracking of families who move from one area of residence to another. Leung & Chen also join **Gelfand & Lun, Iyer et al.**, and **Loughnan et al.** in advocating for the necessity of experimental tests at the individual level. Though this plea for bringing climato-economic research into the laboratory opens up the promising opportunity for proving causation, there is also the danger of erroneously interpreting individual-level reactions as informative representations of population-level processes of culture building. More on the usefulness of experimental investigations of climato-economic habitats follows in R4.2.

R2.9. Practical interventions

The target article sprang from my firm belief that valid theoretical explanations are necessary conditions of effective practical interventions (Van de Vliert 1977; 1985; 1997; see also **Loughnan et al.**). It started with human-rights and human-development objectives to meet human needs, continued with a stepwise examination of climato-economic covariations of fundamental freedoms, and ended at the horizon of scientific engineering of freedom. Against this backdrop, the commentary that comes closest to the gist of the target article is the contribution on sustainable development of mental health by **Desseilles, Duclos, Flohimont, & Desseilles** (Desseilles et al.).

With a keen eye for the multiplexity of causes of mental disorders (e.g., climate, diet, and lifestyle), **Desseilles et al.** are convinced of the importance of climatotherapy as an “adaptive approach aiming to restore balance among the economic, social and ecological realms of human societies” (abstract). Hence, they would like to receive more information about the climato-economics of mental ill-being and the implied need for intervention, also with a view to the links between global warming and sustainability of mental well-being. So far, our research stream has identified only a few pieces of diagnostic and

prognostic information that might be useful for intervention scholars and practitioners alike.

One clinically relevant observation pertains to a diagnostic discrepancy between the ecological prevalences of suicides and mental disorders. In support of climato-economic theorizing, suicides are most prevalent in stressful threatening and stressful challenging habitats and least prevalent in relatively stressless and comforting habitats (Van de Vliert 2009). By contrast, but still in support of climato-economic theorizing, burnout, depression, anxiety, perceived ill health, and unhappiness are most prevalent in threatening habitats, intermediately prevalent in comforting habitats, and least prevalent in challenging habitats (sect. 2.4.2; Fischer & Van de Vliert 2011). Thus, or so it seems, the greater obsession with survival of threatening habitats produces both more suicidal behavior and more mental illness, whereas the greater obsession with self-expression within challenging habitats produces more suicidal behavior but less mental illness.

Put differently, unlike suicide rates that are unrelated to overall freedom ($r = .20$, $n = 49$, $p = .33$), mental disorders tend to mirror the global distribution of freedom ($r = -.63$, $n = 35$, $p < .001$). As a consequence, section 6.3 of the target article may be cautiously read as providing information about scientific engineering from mental illness to mental health. For example, if concerted implementation of climate protection and poverty reduction fails, climatotherapy might be expected to become especially relevant for the African and Asian communities clustered at the bottom of Figure 4 (see target article). Also, Electronic Supplement 6 allows the tentative forecast that unarrested global warming later this century would likely tend to harm climatic livability and related mental health in northern Brazil and southern India unless local economic growth prevents this from happening.

Yet another clinically relevant interaction effect of climatic demands and monetary resources that may be of interest to **Desseilles et al.** was briefly mentioned in section 4.2 and reported in detail elsewhere (Van de Vliert et al. 2013a). Extremely aggressive and persistent employee harassment is most prevalent in threatening habitats, intermediately prevalent in comforting habitats, and least prevalent in challenging habitats. Workplaces have thus more to gain from preventive strategies than from curative strategies in threatening habitats with high employee harassment, which we found to be predominantly concentrated in North-West Asia, East Europe, and Africa. However, in challenging habitats with low employee harassment, as were found to be predominantly concentrated in South and North-West Europe, and in North and South America, preventive organizational strategies may fail to have much of an impact on reducing the problem still further. Instead, tailor-made clinical interventions may be more fruitful.

Coming back to the golden link between valid theoretical explanations and effective practical interventions, and its application to the paradigm at hand, is almost inevitably coming back to the consequential crux of demands and resources. Owing to systematic theorizing and replicative testing of interactive effects of climatic demands and monetary resources, the target article has a solid rule of thumb on offer: climatotherapy and other climato-economic interventions are most effective in stressful threatening habitats, moderately effective in stressful challenging habitats, and least effective in relatively stressless and comforting habitats.

R3. Gray domain

R3.1. Caution: Work in progress

Güss correctly criticizes the target article as resting on too limited operationalizations of needs and freedoms, explicitly warning to be cautious and mindful when generalizing the findings. One cannot be sure yet whether climato-economic theorizing is or is not applicable to, for example, affordable housing and health care, personal and group security, general social inclusion, or mutual respect for diversity and personal growth. Also, it is too early to posit that climato-economic conditions produce free will at the individual level through freedom at the collective level, as Baumeister et al. seem to propose. Or, to pick another example, more work is needed before we can confidently translate Pahlavan & Amirrezvani's concerns about globalization into a viable hypothesis such as this one: poor and rich populations in undemanding climates manifest more cultural convergence than poor and rich populations in demanding climates where localization is more critical for satisfying fundamental needs.

Granted, we have learned that Montesquieu (1748/1989) might have been right all along in insisting that basically people solve livability problems and establish culture when exchanging money for goods and services that satisfy climate-related needs. But we are still struggling with how precisely to measure climatic demands (R2.2), monetary resources (R2.3), and ecological stresses (R2.5), and how precisely to draw the causal path from habitats to adaptations (R2.4). Clearly, this is work in progress whereby replicative climato-economic research of culture and prudence in interpretation are called for.

R3.2. Personality traits

Terracciano & Wayne review evidence for relations between climato-economic conditions and personality traits such as open-mindedness, risk-taking, and hot temperament. However, they searched in vain for significant interaction effects of climatic demands and monetary resources on these reported or attributed traits (for similar insignificant effects on IQ, see R4.4). These expectable findings are in agreement with the definition of personality traits as being invariant over time and across situations (John & Gosling 2000). Yet, it may be premature to conclude that all personality traits are insensitive to climato-economic habitats, also because section 4.4 implies that threatening habitats are home to allocentric personalities whereas challenging habitats are home to idio-centric personalities. Allocentrics think, feel, believe, and act as people typically do in collectivist cultures; idio-centrics think, feel, believe, and act as people typically do in individualist cultures (Triandis 1995; Triandis et al. 1985).

R3.3. Creativity

In addition to the results discussed above under R2.6, Karwowski & Lebuda report that climato-economic theorizing is applicable to country-level creativity reflected in the number of Nobel Prizes in Science and Peace, the number of published papers, and the scholarly H-index. However, this finding may be indicative of some chance

capitalization as well because of the multiple analyses conducted. In addition, climatic demands and monetary resources were unable to interactively predict several other indicators of creativity such as a nation's innovation potential and creative achievements in the arts. Therefore, as yet, general creativity is best conceived as belonging to the gray area where the theory may or may not apply.

R4. Black domain

R4.1. Alternative environments

As observed in the introductory section, the black domain where the climato-economic theory does not apply is vastly larger than the overrepresentation of white-domain topics suggests. Building on work by Boyd and Richerson (2005), Chang et al. hypothesize that environmental variability instead of thermo-economic livability drives cultural adaptation. Seasonal variations in climate, daytime length, and solar radiation, as well as long-term variations in temperature and precipitation, are thought to (a) decrease social learning by collectively copying existing solutions to problems, (b) increase individual learning by personally solving new problems, and (c) promote self-expression, individualism, democracy, and freedom as likely consequences. The results presented in the two panels of Figure R1 do not corroborate this offshoot of climatic determinism. Compared with seasonal switches between low heat and low cold (left side of left panel), seasonal switches between high heat and high cold (right side of right panel) tend to be associated with less rather than more freedom. But recall that Figure R1 is based on cross-sectional data. It would sharpen theoretical boundaries and thus articulate conceptual content if it could be shown that the climato-economic paradigm, although perhaps applicable to centennia-long waves of change (see R2.6), is not applicable to millennia-long waves of climatic variability.

Arantes et al. investigated whether the black domain can be reduced by enlarging the applicability of the ecological demands-resources interaction that is so central to climato-economic theorizing. They attempted to account for press freedom with the demands of natural disaster risks, monetary resources, and their interaction as predictors. As might be expected, this interaction effect did not reach significance because compared to climatic demands, natural disaster risks are less essential theoretically for satisfying the existence needs for thermal comfort, nutrition, and health of the population at large. They also predicted press freedom with climatic demands, oil export resources, and their interaction as predictors. Again the interaction effect was not significant, and again this is not surprising: oil export resources, which appeared to be unrelated to income per head, are unlikely compensators for the greater costs of harsher climates. Factually, Arantes et al. have shown that the climato-economic paradigm has discriminant validity in that it accurately differentiates between theoretically relevant and theoretically irrelevant demands and resources.

R4.2. Not all ambient temperature is climate

Climatic demands are defined and measured as the generalized colder-than-temperate or hotter-than-temperate

weather of a residential area over at least a 30-year period. Consequently, climato-economic ecologies are not obvious predictors of psychobehavioral adjustments in the short run. Accordingly, so far, I have seen no sign that the theory also explains immediate physiological or psychological effects of ambient temperature through incidental weather or indoor climate. Given the current limited applicability of the theory, **Gelfand & Lun**, **Leung & Cheng**, and **Iyer et al.** make useful contributions by suggesting to extend the theoretical domain with the help of ecological priming and other methods for studying individual adjustments to experimental manipulations of climatic demands and monetary resources.

Corresponding questions include: Do threatening climato-economic conditions elicit ingroup agency, autocratic organizing, and low freedom? Do comforting climato-economic conditions elicit convenient agency, laissez-faire organizing, and intermediate freedom? Do challenging climato-economic conditions elicit individual agency, democratic organizing, and high freedom? If laboratory results are able to answer these questions affirmatively, the theory may also hold for short-term exposure to temperature demands and temperature-compensating resources. Rather, my hypothesis is that experiments will fail to find “convergent evidence for the link between ecology and psychological processes” (**Gelfand & Lun**, title). Such disconfirmations would demonstrate the power of the theory to discriminate between its applicability to climatic demands and monetary resources as macro-level environments and its inapplicability to temperature demands and temperature-compensating resources as micro-level environments.

Vigil, Swartz, & Rowell (**Vigil et al.**) provide an instructive example of a climatic demands-resources experiment with ample room for improvement in the direction of what **Gelfand & Lun** and **Leung & Cheng** have in mind. First, the 202 participants in **Vigil et al.**'s experiment were not selected and assigned to conditions based on their coming from places of residence with either undemanding or demanding thermal climates. Second, ambient room temperatures only varied between 68°F and 77°F, with no manipulation of low and high temperatures outside of this comfort zone. Third, no conditions of low versus high levels of temperature-compensating resources were primed or structurally manipulated. Fourth, the dependent variables of capacity (Cronbach's $\alpha = .42$), trustworthiness ($\alpha = .43$), and desiring more independence ($\alpha = .22$) were not reliably measured. Thus, this experiment makes a significant contribution by exposing a number of critically important design features of the proposed climato-economic experiments.

R4.3. Human intelligence

The worldwide distribution of human intelligence is strongly related to annual mean temperature ($r = -.63$; **Lynn & Vanhanen 2006**). **Allik & Realo** therefore consider it a missed opportunity that I did not check whether climato-economic conditions are even better predictors of national IQ (source: **Lynn & Vanhanen 2006**). Using the predictors from **Table R2**, I found that heat demands, cold demands, monetary resources, and their four interactions accounted for 62% of the variation in IQ across 106 countries. Despite the 22% increase in predictive

power, these results still imply that global inequality in IQ belongs to the black domain of cultural adaptations to climato-economic conditions because none of the four interaction effects reached significance.

In a double check, IQ was added to each of the six prediction models in **Table R2**. In Model 1, national IQ predicted 46% of the variation in overall freedom ($b = .04$, $n = 71$, $p < .01$), wiping out the initial impact of parasitic disease burden ($b = -.11$, $p = .12$). However, Models 2 to 6 then wiped out the initial impact of national IQ, showing that neither intelligence nor parasitic disease burden mediates the interactive influences of heat demands, cold demands, and monetary resources on overall freedom. In Model 6, national IQ ($b = .01$, $p = .23$), parasitic disease burden ($b = .04$, $p = .55$), heat demands ($b = -.20$, $p < .05$), cold demands ($b = -.09$, $p = .51$), the interaction of heat and cold demands ($b = .02$, $p = .88$), monetary resources ($b = .36$, $p < .01$), the interaction of heat demands and monetary resources ($b = -.04$, $p = .76$), the interaction of cold demands and monetary resources ($b = .50$, $p < .001$), and the three-way interaction ($b = -.10$, $p = .42$), accounted for 75% of the variation in freedom from press repression, ingroup discrimination, and political autocracy. In sum (and in response to **Allik & Realo**), there is not the slightest indication that **Lynn** and **Vanhanen (2006)** were right in assuming that national IQ drives governmental democratization.

R4.4. Fitness advantages of adaptation

Adaptation is a complex construct that defies simple definition. To me, adaptation is the evolution or development of shared appraisals of stresses and shared choices of goals and means that help satisfy fundamental needs in a given habitat (sect. 2.4). **Paternotte**, however, restricts adaptation to not only the use of traits but also to the development of traits that provide an evolutionary fitness advantage for either the individual or the group. In the target article, the words *trait* and *fitness* are never mentioned, let alone that fitness advantages of individual-trait adaptation are distinguished from fitness advantages of group-trait adaptation. Although **Paternotte** is therefore storming a house in which I do not live, his perspective of fitness advantages may still be useful to clarify the role of survival in the creation of culture from a climato-economic vantage point.

Creeping slow, processes of cultural evolution reduce two universal human problems: climatic survival and genetic survival (**Van de Vliert 2009; 2011b**). Climatic survival in a particular place is the more important one simply because it is a necessary but insufficient condition for sexual reproduction and genetic survival over time. Cultural reductions of climatic-survival problems apply to warm-blooded males and warm-blooded females in the same way, whereas cultural reductions of genetic-survival problems apply to sperm-contributing males and egg-contributing females in different ways. As a current consequence, climato-economic theorizing has something to say about ungendered culture, including shared fundamental freedoms, but next to nothing about gendered culture, including masculinity and femininity (for gendered culture, see **Emrich et al. 2004; Hofstede 1998; 2001; Van de Vliert et al. 2000**).

Paternotte's perspective seems valuable indeed for associating ungendered cultural characteristics with fitness advantages to undifferentiated groups of humans and gendered cultural characteristics with fitness advantages to males and females separately. If these culture-fitness relationships are real and vital, they might even explain why collectivist values and motives, ingroup identification, and "ingroup favoritism appeared to be higher in ungendered cultures than in both masculine and feminine cultures" (Van de Vliert 2011b, p. 509). However that may be, until more advanced research shows otherwise, the field of gendered culture lies outside the more generic domain of climato-economic description and explanation of ungendered human culture.

R4.5. Do animals belong on the black list?

Much to **Burghardt's** regret, the target article examines demands, resources, and adaptations solely through a human-focused anthropocentric lens. Of course, animals also adapt their courses of action to the habitational circumstances of climatic demands and resource availability, and it is a very smart idea to investigate playfulness in nonhumans as a surrogate measure for freedom of choice in humans. It is a promising idea, too, given that nonhuman species mirror the human pattern of repression of fundamental freedoms: "play of all types is readily curtailed in both the wild and captivity in times of food shortage, climatic adversity, social upheaval, and chronic stress" (Burghardt 2005, p. 157). By contrast, play in all species is most prevalent when there are excess resources along with bodily attributes that facilitate flexibility, novelty, and creativity. For example, Japanese macaques living in relatively threatening habitats have a more rigid social system and are less playful and cooperative than macaques living in relatively comfortable habitats in Indonesia. I wholeheartedly agree with Burghardt that such findings open up many avenues of fruitful comparative research.

R5. Prospect

This discussion platform has supplied rich fodder for psychobehavioral scholars who set out to systematically describe, explain, and adjust how differently humans function spatially. The commentaries reflect considerable potential for refining, extending, and putting to use the burgeoning geographical understanding of climato-economic conditions under which fundamental needs are being transformed into culture. As to practical relevance, the day may come and may not be far off when space- and satellite-based systems such as the Global Positioning System (United States) and the BeiDou Navigation System (China) provide specific cultural information about the residents of every inhabited spot on earth.

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[The letters "a" and "r" before author's initials stand for target article and response references, respectively]

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